smiths

EQ-5000
EQUATOR®
Convective Warmer

REF EQ-5000 100V
REF EQ-5000 115V
REF EQ-5000 230V

Service Manual

P/N 4533902-GB Rev A

Copyright

EQUATOR® Convective Warmer

Part Number: 4533902-GB Rev. A (2005-01)

This revision supercedes all previous revisions.

Under copyright laws, this manual may not be reproduced in any form, in whole, or in part, without prior written permission of Smiths Medical ASD, Inc. (Smiths Medical ASD).

Level 1 and EQUATOR are trademarks of the Smiths Medical family of companies. The symbol ® indicates the trademark is registered in the U. S. Patent and Trademark office and certain other countries.

Every effort has been made to ensure that the information in this manual is accurate and details provided are correct at the time of printing. The company, however, reserves the right to improve the equipment shown.

Other company and product names mentioned herein are trademarks of their respective companies. Mention of third-party products is for informational purposes only and constitutes neither an endorsement nor a recommendation. Smiths Medical ASD assumes no responsibility with regard to the performance or use of these products.

For further information, please call the local Smiths Medical ASD representative or Smiths Medical ASD direct at 1-800-258-5361 or +1-781-878-8011.

©2005 Smiths Medical family of companies.

All rights reserved.

The products described are covered by one or more of the following U.S. Patent Nos. 5,785,723; 6,143,020; 6,277,144; 6,440,157; other patent(s) pending; foreign patent(s) pending.

Manufactured in the U.S.A.

Contents

Introduction v
Abbreviations Used in the Manual vi
Appropriate Use and Service vi
Indications for Use vi
Symbols vii
Service Information ix
Warranty Service ix
Non-Warranty Service ix
Returning the Device for Service x
Service Contacts x
Important Safety Information xi
1 Description 1
EQUATOR® Convective Warmer 1
Convective Warming Blankets 1
Control Panel 2
2 Preventive Maintenance 3
Recommended Schedule 3
Cleaning the Hose and Enclosure 3
Replace the Air Filter 4
3 Functional Test and Calibration Procedure 7
Functional Test and Calibration Procedure Checklist 7
Instrument Test Setup 9
Preliminary Voltage Checks and Adjustments 10
Functional Tests 12
Test 1: Self-Test Sequence 12
Test 2: Disconnect Indicator Test 13
Test 3: HI Temperature Test 14
Test 4: MED Temperature Test 16
Test 5: LO Temperature Test 17
Test 6: LO OverTemp and UnderTemp Test 18
Test 7: MED OverTemp and UnderTemp Test 18
Test 8: HI OverTemp and UnderTemp Test 19
Test 9: Ambient OverTemp Test 19
Test 10: OverTemp and UnderTemp Readjustment 20
Test 11: Temperature DownStep Alarm Delay Check 21
Test 12: Fire Safety Thermostat Function Test 22
Test Completion 22
Shut Down the Instrument 22
Determine Instrument Disposition 23
4 Component Removal and Replacement 25
Open the Enclosure 26
Replace the Motor Driver Electronic Assembly 28
Replace the Motor 30
Replace the Impeller 32
Replace the Heater 32
Replace the Hose Microswitch Assembly 34
Replace the Air Outlet 34
Replace the Pole Clamp 35
Replace the Control Panel 36
Replace the Power Supply Assembly 38

A Reference Diagrams 39
B Troubleshooting 43
General Failures 43
Airflow Failures 44
Heat Related Failures 44
Self-Test Does Not Complete 45
Self-Test Completes 46
Thermal Runaway – Device Causes T-Stat to Open 47
Safety Leakage Test 47
C Specifications 49
D Parts List 51
E Schematic Drawings 55
Maintenance Log 61

Introduction

This manual provides qualified hospital facility biomedical technicians and other qualified service facility personnel with procedures to service and make repairs to the EQUATOR® Convective Warmer – 100V/115V/230V. Only trained, qualified personnel knowledgeable of the good practices for servicing and repairing medical devices should service the device. Perform service and repairs according to the procedures described in this manual.

WARNING!

- **Electrocution Hazard. There are no user-serviceable parts inside the enclosure. Only competent personnel knowledgeable in the safety procedures required for servicing live Mains parts shall be allowed to open the enclosure.**

Note: *Any EQUATOR® Convective Warmer circuit modifications or electronic assembly component replacements by persons other than those authorized by Smiths Medical ASD are strictly forbidden.*
Any adjustment or repair of the EQUATOR® Convective Warmer must be performed at a properly grounded ESD workstation using the procedures presented in this manual.

Read and follow instructions and all accompanying documents. Failure to follow instructions could lead to misuse of the device or device malfunction.

The manual is divided into the following sections:

Section	Contains
Chapter 1	Describes general information about the device
Chapter 2	Procedures to perform scheduled maintenance
Chapter 3	Functional tests used to check the safety functions of the device
Chapter 4	Procedures to replace components of the device
Appendix A	Diagrams for the Mains and Control Electronic Assembly
Appendix B	Causes and solutions for troubleshooting device issues
Appendix C	System specifications
Appendix D	List of parts available to order
Appendix E	Circuit drawings
Maintenance Log	Form to record maintenance tasks

Abbreviations Used in the Manual

Abbreviation	Definition
DVM	Digital Volt Meter
TA	Thermo-Anemometer
TP	Test Points
LED	Light Emitting Diode
AMB	Ambient – Room Temperature
LO	Low Temperature – 36°C
MED	Medium Temperature – 40°C
HI	High Temperature – 44°C
OT	Over Temperature
UT	Under Temperature

Appropriate Use and Service

Smiths Medical ASD cannot assume responsibility for performance, safety, and reliability of the device when any of the following situations occur:

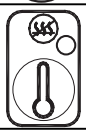
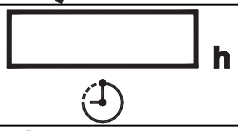
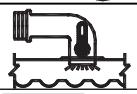
- Any adjustments and repairs are performed by unauthorized personnel.
- The device is not used according to the manufacturer's recommendations.
- The procedures described in the *EQUATOR® Convective Warmer Operator's Manual* and in this service manual are not followed.
- Environmental operating conditions and location recommendations are not followed.

Indications for Use

The EQUATOR® Convective Warmer is intended for thermal regulating of a patient's temperature by a warm-air-heated blanket system. It is designed to prevent hypothermia and/or reduce cold discomfort before, during, and after surgical procedures. It is intended for use by appropriately trained healthcare professionals in clinical environments.

Symbols

The following symbols are used in the manual, and on the device and disposables.

Symbol	Definition
	Power ON Button
	Power OFF Button
	Ambient Temperature Setting Button (Start up setting)
	36°C Temperature Setting Button
	40°C Temperature Setting Button
	44°C Temperature Setting Button
	Over Temperature Alarm Indicator
	Under Temperature Indicator
	Disconnect LED
	Elapsed Time Display (h=hour)
	Hose End Temperature
	Type BF Equipment
IPX1	Protected Against Dripping Water

Symbol	Definition
REF	Catalog Number
SN	Serial Number
PN	Part Number
LOT	Batch Code
EC REP	Authorized Representative in the European Community
	Manufacturer
	Date of Manufacture
	Quantity
	Protective Earth [Ground]
	Alternating Current
	Do Not Reuse
	Attention, see instructions for use
	Electrical Shock Hazard
	Latex Free
Rx ONLY	Caution: Federal law (U.S.A.) restricts this device to sale by or on the order of a physician.
	Protective earth terminal
	Temperature limitation
	Use by

Symbol	Definition
	Recyclable Product
	Device has been tested by National Technical Systems, a nationally recognized technical lab, to meet U.S. requirements for safety.
CE 0473	CE Mark and Notified Body number (0473 indicates AMTAC)
	Humidity limitation
STERILE EO	Sterilized using ethylene oxide
	Non-sterile
CONTRAINDICATION	A Contraindication statement alerts the user to conditions when the device should not be used.
CAUTION!	A Caution statement alerts the user to conditions that may cause damage to the device.
WARNING!	A Warning statement alerts the user to conditions that may cause personal injury to the user or patient.

Service Information

All service must be performed by Smiths Medical ASD or a Smiths Medical ASD authorized representative. Service by any other person or organization voids the warranty and transfers liability for malfunctions of the device to the servicing organization.

Warranty Service

Devices received for repair that have not been obviously abused or impact-damaged and are still under warranty will be promptly repaired and returned at no charge. A no-charge purchase order is requested for tracking. Refer to the *EQUATOR® Convective Warmer Operator's Manual* for the complete text of the limited warranty.

Non-Warranty Service

Devices received that have suffered obvious abuse or impact damage and devices no longer under warranty will be promptly inspected and a verbal

estimate of repair cost will be given to you. A purchase order will be required from the hospital consistent with the verbal estimate. A written estimate will be provided upon request.

Returning the Device for Service

Before returning the EQUATOR® Convective Warmer for service, contact Smiths Medical ASD for Returned Goods Authorization.

Note: *The EQUATOR® Convective Warmer must be cleaned and disinfected for repair shipment or it will be immediately returned as received.*

Service Contacts

Contact Smiths Medical ASD Technical Service Department or Smiths Medical ASD distributor at:

USA/Canada

Smiths Medical ASD, Inc.
Anesthesia and Safety Devices Division
160 Weymouth Street
Rockland, MA 02370 USA

USA/Canada 1-800-258-5361
International 1-781-878-8011

European Representative

Smiths Medical International Ltd
Watford, Herts,
WD24 4LG, UK

Tel +44 (0) 1923 246434
Fax +44 (0) 1923 240273

Australian Representative

Smiths Medical Australasia Pty. Ltd.
61 Brandl Street, Brisbane Technology Park
Eight Mile Plains, QLD 4113, Australia

Tel +61 (0) 7 3340 1300
Fax +61 (0) 7 3340 1399

Important Safety Information

CONTRAINDICATIONS

- **Thermal injury may occur if convective warming therapy is applied to lower extremities during aortic cross-clamping procedures.**
- **Thermal injury may occur if convective warming therapy is applied to ischemic limbs.**

WARNING!

Death or serious injury may occur if these warnings are not followed:

- **Read and follow all instructions and accompanying documents. Failure to follow instructions could lead to misuse of the device or device malfunction.**
- **Electrocution Hazard. There are no user-serviceable parts inside the enclosure. Only competent personnel knowledgeable in the safety procedures required for servicing live Mains parts shall be allowed to open the enclosure.**
- **Blankets are for single use only. To reduce the risk of cross contamination, do not reuse blankets.**
- **Cover all open wounds under the warming blanket to prevent airborne contamination.**
- **Grounding reliability can only be achieved when the Mains power cord is connected to a properly grounded receptacle. Risk of electrical shock exists if the equipment is not connected to a properly grounded receptacle resulting in death or serious injury to the patient or user.**
- **Exposed conductors on the Mains power cord can cause an electrocution hazard. Remove the device from service if the Mains power cord has exposed wires.**
- **The EQUATOR® Convective Warmer must be calibrated by Smiths Medical ASD or Smiths Medical ASD authorized personnel.**
- **Do not use the EQUATOR® Convective Warmer in high-energy fields such as: Cauterizers, MRI, X-RAY, portable and mobile RF communications equipment, and other such devices. The EQUATOR® Convective Warmer may act as a projectile in a strong magnetic field, cause image artifacts, or not function as intended.**
- **Do not use the EQUATOR® Convective Warmer in the presence of a flammable anesthetic mixture with air, oxygen, or nitrous oxide. The risk**

of explosion exists if the device is operated in a potentially explosive environment.

- **To prevent fire hazard and possible damage to the EQUATOR® Convective Warmer, use only fuses specified. Only competent personnel knowledgeable in the safety procedures required for servicing live Mains parts shall be allowed to open the enclosure.**

CAUTION!

Thermal injury may occur if these cautions are not followed:

- **If Over Temperature audible alarm sounds and/or red Over Temperature alarm indicator illuminates, discontinue use of the convective warmer and remove from service. Contact Smiths Medical ASD or an authorized representative for service.**
- **If the EQUATOR® Convective Warmer does not perform its self-test properly, fails to operate, or stops while running, discontinue use of the convective warmer and remove it from service. Contact Smiths Medical ASD or an authorized representative for service.**
- **Hose Nozzle MUST be connected to a compatible Forced Air Blanket.**
- **Monitor the temperature of the patient at regular intervals.**
- **Periodically observe cutaneous response under blanket. If erythema is evident, decrease the temperature setting or discontinue use of convective warming therapy.**
- **Do not place objects onto the blanket that will obstruct airflow.**
- **If equipment malfunction is evident, discontinue use of the EQUATOR® Convective Warmer and remove it from service. Contact Smiths Medical ASD or an authorized representative for service.**
- **Use only blankets manufactured and/or approved by Smiths Medical ASD.**
- **Warming unit must be calibrated by competent personnel authorized by Smiths Medical ASD.**
- **Federal law (USA) restricts this device to sale by or on the order of a physician.**

Physical injury to the user and/or patient may occur if these cautions are not followed:

- **Ensure that the EQUATOR® Convective Warmer IV pole mounting clamp is properly tightened before each use.**

- **Do not mount the EQUATOR® Convective Warmer higher than 46” (1.17m) on the IV pole. For convenience, 46” (1.17m) is indicated by a black mark on the EQ-5000 power cord. Mounting the device above 46” (1.17m) may result in instability of the pole and tipping.**
- **Do not change filter while unit is operating.**

1 Description

EQUATOR® Convective Warmer

The EQUATOR® Convective Warmer is used to reduce hypothermia and patient discomfort before, during and after surgical procedures. The system consists of a high-flow warming device with hose-end temperature control and a single-use blanket.

The EQUATOR® Convective Warmer draws ambient-temperature air through a particulate air filter. The filtered air is warmed to a selected temperature. The warmed air enters the blanket through the hose and is distributed through delivery channels to the patient. Perforations on the patient side of the air delivery channels in the blanket gently disperse warm air over the patient, thereby maintaining patient temperature.

The warming device has three outlet temperature settings that provide flexibility in patient treatment: 36°C, 40°C, and 44°C. These three temperature settings are servo-controlled by thermistors placed at the hose end that connects to the blanket. A fourth temperature setting delivers ambient-temperature air.

The temperature indicated on the display of the warming device is the temperature of the air being delivered to the blanket at the end of the hose.

An over-temperature system monitors the air temperature at the end of the hose that connects to the blanket. A control thermistor adjusts the power applied to the heater in the warming device to maintain the selected temperature. This enables the system to maintain the selected temperature under variations in ambient temperature.

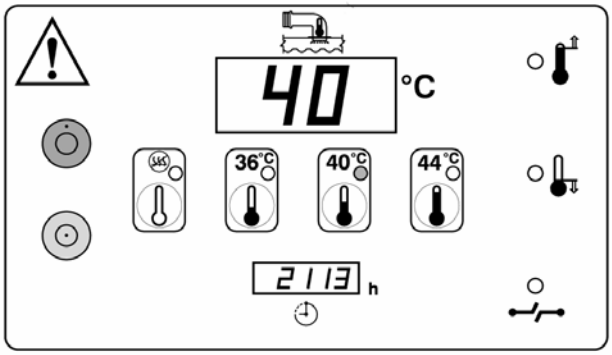
A safety thermistor provides a signal to a separate high temperature comparison circuit. The safety thermistor activates and alarms if the temperature exceeds the set point. The safety circuit provides an independent means of shutoff, which discontinues power to the heater and blower. This prevents patient exposure to excessive temperatures in a single fault failure of the temperature controller.

Convective Warming Blankets

The blanket consists of two layers of non-woven polypropylene fabric coated with a layer of polyethylene. The layers are bonded together to form a distribution network of air delivery channels. The warm air is distributed around the blanket through the delivery channels and exits the blanket through a specially designed series of perforations in the patient side of the blanket. The distribution of air is designed to minimize temperature differences throughout the blanket.

Control Panel

Figure 1-1 identifies the controls and indicators seen on the control panel.



Symbol	Definition
	Power ON Button
	Power OFF Button
	Ambient Temperature Setting Button (Start up setting)
	36°C Temperature Setting Button
	40°C Temperature Setting Button
	44°C Temperature Setting Button
	Over Temperature Alarm Indicator
	Under Temperature Indicator
	Disconnect LED
	Attention, consult accompanying documents
h	Elapsed Time Display (h=hour)
	Hose End Temperature

Figure 1-1 Controls and Indicators

2 Preventive Maintenance

The EQUATOR® Convective Warmer (device) requires only minimal preventive maintenance to maintain its appearance and assure normal operation over the life of the instrument.

Recommended Schedule

- Enclosure cleaning: semi-annually, or as required to preserve the enclosure's appearance.
- Hose cleaning: as necessary.
- Replacement of the air filter: annually, or as required to assure unrestricted airflow.

Tools and Equipment

The following tools, equipment, and cleaning agents are necessary to perform the maintenance procedures explained in this chapter:

- For enclosure and hose cleaning: a mild, non-abrasive detergent diluted in warm water.
- For air filter replacement: Phillips-head screwdriver.

Cleaning the Hose and Enclosure

1. Disconnect the power cord from both the electrical outlet and from the rear of the device.
2. If a chassis-ground cable is connected to the grounding stud (located below the power cable connector) at the rear of the device, disconnect the cable.
3. Remove the hose from the device:
   a. Disconnect the hose thermistor cable from the rear of the device by turning the knurled knob on the thermistor receptacle counterclockwise, until the cable can be unplugged and removed from the device.
   b. Grasp the hose connector, twist, and pull it straight out from the air outlet at the rear panel.
4. Remove the device from the pole if pole mounted.

5. Using a dampened cloth or sponge, wipe down the enclosure and hose as needed.

   Note: *Do not use alcohol or other strong solvents to clean the hose or exterior surfaces of the device. These solutions may damage the label and other parts.*

   Note: *Do not use a soaking wet cloth to clean the hose or exterior surfaces of the device. Water may drip or seep into the electrical connectors and components at the rear of the device and into the air intake opening at the bottom of the enclosure. Electrical components and the air filter could be damaged if they become wet.*

6. Wipe the entire enclosure and hose dry using a soft, dry cloth.
7. Record the task on the maintenance log.

Replace the Air Filter

CAUTION!

- **Do not change the air filter while the device is operating.**

---

1. Disconnect the power cord from both the electrical outlet and from the rear of the device.
2. Remove the device from the pole if pole mounted. Lay device on its side.
3. Remove the four small Philips screws on bottom securing the filter in place. Refer to Figure 2-1.

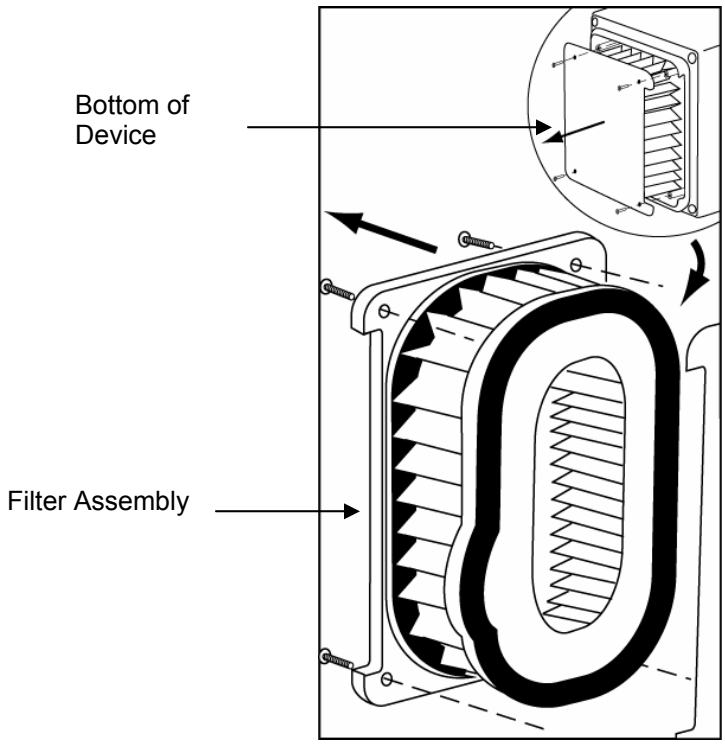


Figure 2-1 Air Filter Replacement

4. Discard the old filter assembly.
5. Inspect the new filter gasket assembly to be sure it is clean and unmarked.
6. Install new filter assembly using the original screws.
7. Record the task on the maintenance log.

3 Functional Test and Calibration Procedure

The Functional Test and Calibration Procedure is a series of tests used to determine if the EQUATOR® Convective Warmer (device) is operating within its design specifications and that all safety features are functional. The procedure also describes steps to perform minor adjustments that may be required.

Some test procedures require service access to components that are internal to the device. For information describing how to access those internal components, refer to the *Open the Enclosure* procedure in Chapter 4.

Tools and Equipment

The following tools and equipment are needed to perform the Functional Test and Calibration Procedure:

- 4½ digit Digital Volt Meter (DVM)
- Stopwatch
- Calibrated thermo-anemometer (TA)
- Meter/Power supply cable

Functional Test and Calibration Procedure Checklist

The following table shows the *Functional Test and Calibration Procedure Checklist* required for the test procedures in this chapter. The Checklist provides a convenient tool for measuring/recording test results against appropriate default tolerance values specified for each procedure.

Note: *Copy the Checklist for use during the Functional Test and Calibration Procedure*.

Functional Test and Calibration Procedure Checklist

Device Serial Number:		**Date of Test:**	
Name of Technician:			
Test Item Number	**Method**	**Tolerance**	**Test Result**
1. Self-Test Sequence	Verification	Verify Pass/Fail ✓	Pass □ Fail □
2. Disconnect Indicator Test	Verification	Verify Pass/Fail ✓	Pass □ Fail □
3. Disconnect Safety Test	Verification	Verify Pass/Fail ✓	Pass □ Fail □
4. HI Temp Reading (TA)	TA Read	43-45°C	°C
5. HI Temp Reading (Control panel)	Device Read	43–45°C	°C
6. HI Temp Reading (DVM)	DVM Read	0.435–0.455 Vdc	Vdc
7. HI Temp Airflow (w/New filter)	TA Read	1650–1850 ft/min	ft/min
8. MED Temp Reading (TA)	TA Read	39-41°C	°C
9. MED Temp Reading (Control panel)	Device Read	39–41°C	°C
10. MED Temp Reading (DVM)	DVM Read	0.395–0.415 Vdc	Vdc
11. LO Temp Reading (TA)	TA Read	35-37°C	°C
12. LO Temp Reading (Control panel)	Device Read	35–37°C	°C
13. LO Temp Reading (DVM)	DVM Read	0.355–0.375 Vdc	Vdc
14. LO UT/OT Test	Verification	Verify Pass/Fail ✓	Pass □ Fail □
15. LO OT Temp Reading	Device Read	38–40°C	°C
16. MED UT/OT Test	Verification	Verify Pass/Fail ✓	Pass □ Fail □
17. MED OT Temp Reading	Device Read	42–44°C	°C
18. HI UT/OT Test	Verification	Verify Pass/Fail ✓	Pass □ Fail □
19. HI OT Temp Reading	Device Read	46– 48°C	°C
20. AMB OT Temp Reading	Device Read	46– 48°C	°C
21. Downstep Alarm Delay	Stopwatch	60–90 sec	sec
22. Thermostat Function (turns OFF)	Stopwatch	130 sec (Max)	sec
23. Thermostat Function (resets ON)	Verification	Verify Pass/Fail ✓	Pass □ Fail □
24. DIP Switches at SW1 all to ‘NORM’	Verification	Verify Pass/Fail ✓	Pass □ Fail □

Instrument Test Setup

Prepare the EQUATOR® Convective Warmer for testing by connecting the hose and the thermistor cable to the rear of the device.

1. Remove the top of the enclosure. Refer to the *Open the Enclosure* procedure in Chapter 4.

WARNING!

- **Electrocution Hazard. There are no user serviceable parts inside the enclosure. Only competent personnel knowledgeable in the safety procedures required for servicing live Mains parts shall be allowed to open the enclosure.**

---

2. Elevate the EQUATOR® Convective Warmer ½" or more off the table or bench top to allow for adequate airflow. Keep rear air inlet unobstructed. Be careful not to disconnect any wires from the Control Electronic Assembly when removing the top of the enclosure.
3. Ground the motor mounting plate to the rear chassis with a clip lead while the enclosure is open.

   Note: *Do not make a permanent ground connection between the motor mounting plate and the chassis. If a permanent ground connection is made, the device will fail the Electrical Safety Test because of high leakage current.*

Preliminary Voltage Checks and Adjustments

1. Plug the EQUATOR® Convective Warmer into the appropriate 110VAC, 115VAC or 230VAC power outlet.
2. With the DVM connected to the Test Points at TP100 and TPSG, check the voltage measurements shown in the following table. Make adjustments if necessary. Refer to Figure 3-1 for the locations.

DVM(+)	DVM (-)	Min Val (V)	Max Val (V)	Notes	Test
TP100	TPSG	2.048	2.052	Adjust R100 (2.050V nom)	Vref

3. Connect the DVM to Test Points at TP107 and TPG.
4. Adjust R107 counterclockwise until the “CS” LED turns ON, and then turn R107 clockwise until the LED just turns OFF.
5. Observe the voltage measurement at TP107 on the DVM. Then readjust R107, adding 0.25V to the observed TP107 reading.

Note: *If the “CS” LED does not turn ON when adjusting R107, set theTP107 reading on the DVM to 0.25V.*

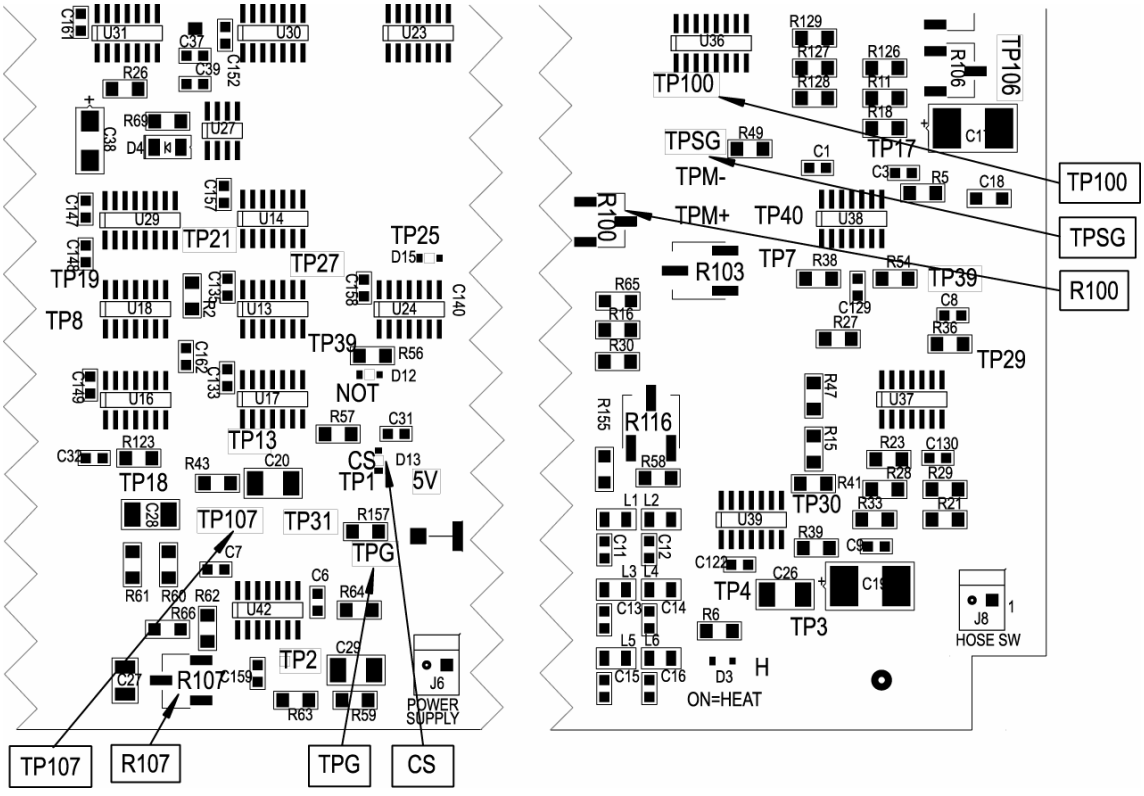


Figure 3-1 Locations for TP100, TPSG, R100, TP107, TPG, CS, and R107

6. Plug the DVM into the METER connector on the Control Electronic Assembly with the appropriate cable, or connect the wires to Test Points at TPM+ (Meter +) and TPM- (Meter -) on the electronic assembly. Refer to Figure 3-2 for the locations.

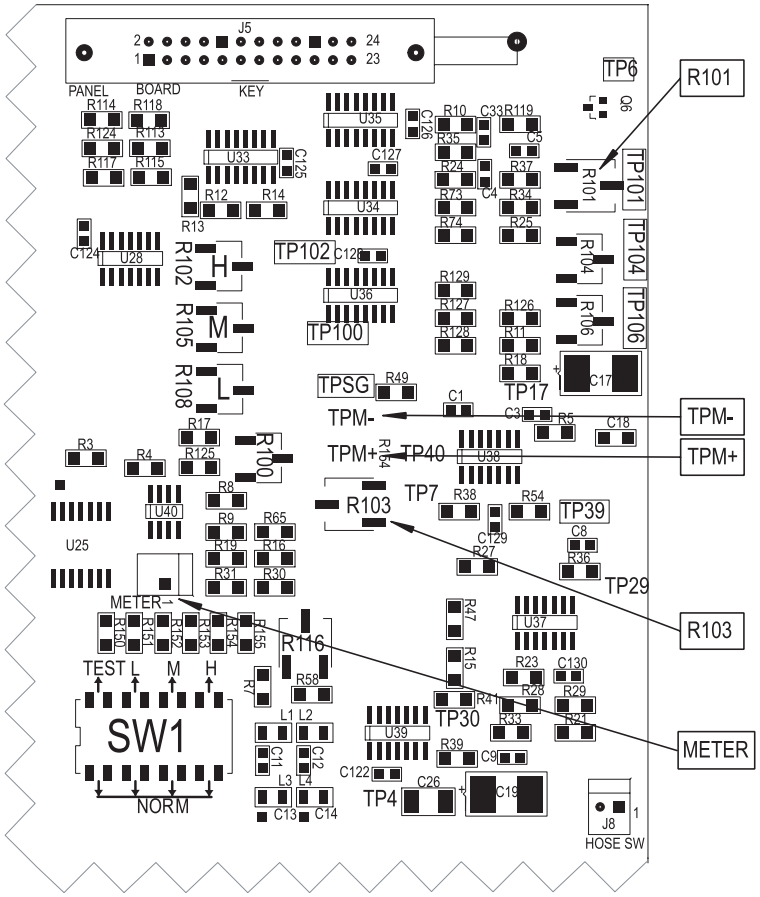


Figure 3-2 Locations for R101, TPM-, TPM+, R103, and METER

7. Check the control panel and verify that no LEDs are lit and both displays are blank.

Functional Tests

Perform all 12 functional tests in the order they are presented in the following pages. Be sure to read through each test to obtain an understanding of the steps involved in each individual procedure before starting. Use the *Functional Test and Calibration Procedure Checklist* described earlier in this chapter as a guide and to record the test results.

Note: *When performing any forced overtemp check, always start with the device turned OFF.*

Test 1: Self-Test Sequence

The self-test sequence checks that the automatic self-test functions properly when the device is turned ON.

1. Press the ON button and allow the device to complete its self-test sequence.
2. During the self-test sequence, check the control panel to verify that all of the push-button LEDs and the UT LED ( ) are lit, and at the same time that the following sequence occurs:

- Temperature Thermistor Open Circuit check OK = Flash .
- Safety Thermistor Open Circuit check..... OK = Flash .
- Open Heater Detector Circuit check..... OK = Flash .
- Safety Thermistor OverTemp check..... OK = Flash and BEEP.

3. Check that all the LEDs turn off, except the AMB button LED, and that the blower continues to run.
4. The self-test is completed. Check **Pass** for item 1 on the Checklist.

   Note: *If the self-test sequence did not complete properly, check **Fail** on the Checklist and refer to Appendix B, Troubleshooting.*

Test 2: Disconnect Indicator Test

1. If necessary, press the OFF button, then press the ON button. Wait for the self-test to complete.
2. Disconnect the hose thermistor cable from the rear of the device. Verify that the Disconnect LED (🔌) lights, the beeper beeps, and the blower stops.
3. Check that the red **SAFETY** LED by J4 on the Control Electronic Assembly is **NOT** lit. Refer to Figure 3-3 for the location.

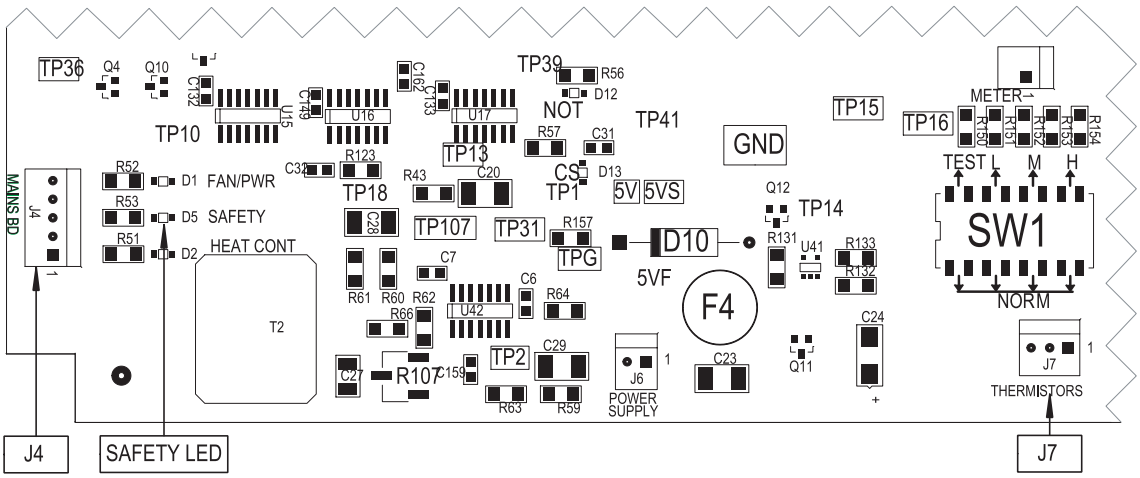


Figure 3-3 Location for The SAFETY LED near J4

4. Press the OFF button and then press the ON button. The self-test should stop on the first test.
5. Reconnect the thermistor cable. The self-test should continue to completion.
6. Disconnect the hose from the rear of the device. Verify that the Disconnect LED (🔌) lights, the beeper beeps, and the blower stops.
7. Reconnect the hose. Verify that the Disconnect LED (🔌) turns off and the device continues to run. Check **Pass** for item 2 on the Checklist.
8. Press the HI button. Wait for the temperature to rise to approximately 30°C.
9. Disconnect the hose from the rear of the device. Verify that the Disconnect LED (🔌) lights, the beeper beeps, and the blower stops.
10. Reconnect the hose. Verify that the Disconnect LED (🔌) turns off, the blower restarts, and the temperature continues to increase toward 44°C.
11. Press the AMB button. Check **Pass** for item 3 on the Checklist.

Test 3: HI Temperature Test

This test verifies the HI temperature readings and speed of the airflow.

Note: *It is very important to know the calibrated accuracy of the TA used for the following tests.*

1. Connect the TA with the restrictor attached to the end of the hose elbow.
2. Stretch the hose (SW5 HOSE7) out from rear of device to its full length of 2.1 meters (7 ft) from the enclosure to the end of the hose elbow. Be sure the TA collar covers all of the slots at the hose elbow. Set the TA to read air speed in feet/minute and temperature in °C.
3. If necessary, press the OFF button, then press the ON button. Wait for the self-test to complete.
4. Press the HI button

and allow the temperature to stabilize for at least 5 minutes.
5. Verify that the air speed is between 1650 and 1850 ft/min (1750 ft/min nominal). If the air speed is low, check the air filter for cleanliness and replace if necessary.
   If the airflow is outside the limits, readjust the motor speed. The adjustment potentiometer is located on the edge of the motor driver electronic assembly to the rear of the enclosure. Refer to Figure A-3 in *Appendix A* for the location of the potentiometer.

   Note: *Use a very long, (45.7 cm [18"]) slotted, insulated screwdriver to access the potentiometer behind the motor. Live AC Mains voltage is present at the Mains Electronic Assembly. Touching the metal shaft to the Mains Electronic Assembly could result in serious injury or death. This type of contact also can damage the electronic assembly and cause malfunction of the device.*

WARNING!

- **Electrocution Hazard. There are no user-serviceable parts inside the enclosure. Only competent personnel knowledgeable in the safety procedures required for servicing live Mains parts shall be allowed to open the enclosure.**

Note: *If adjusting the potentiometer does not adjust the speed, the motor driver electronic assembly DIP switches, if installed, may be set incorrectly. Refer to Figure A-3 in Appendix A for the correct setting of motor DIP switches setting.*

6. After the temperature has stabilized, verify that the HI temperature readings appear as follows:

- TA HI Temperature Reading: 43.0 – 45.0°C (44.0°C nominal)
- Device HI Temperature Display: 43 – 45°C (44°C nominal)
- DVM HI Temperature Reading: 0.435V – 0.455V (0.445V nominal)

7. If necessary, slowly readjust R102 (hose end H) for a TA reading of 43.8°C – 44.2°C (44.0°C nominal) and/or readjust R103 (LO) for a DVM reading of 0.443V – 0.447V (0.445V nominal). Refer to Figure 3-4 for the locations. Wait until the readings on the TA stabilize.

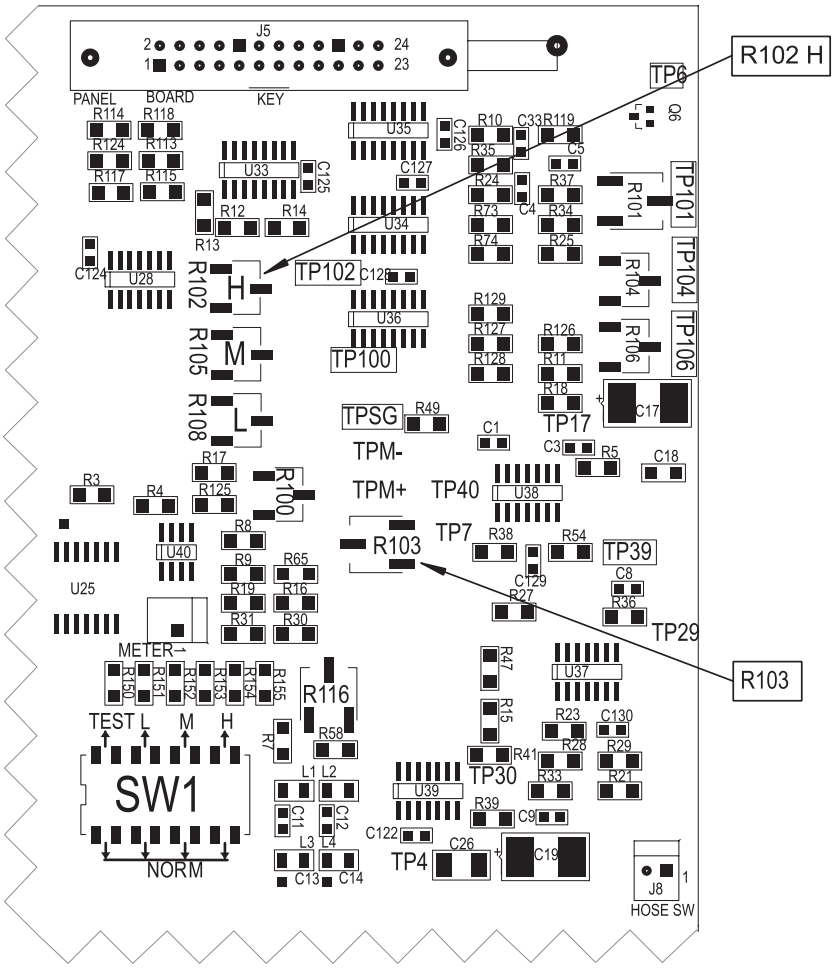


Figure 3-4 Locations for R102, R103

8. Record the TA Temperature Reading (item 4), control panel Temperature Reading (item 5), DVM Reading (item 6), and TA feet/minute Reading (item 7) on the Checklist.

Test 4: MED Temperature Test

1. Press the MED button

, and allow the temperature to stabilize for at least 5 minutes.
2. After the temperature has stabilized, verify that the MED temperature readings appear as follows:

- TA MED Temperature Reading: 39.0°C – 41.0°C (40.0°C nominal)
- Device MED Temperature Display: 39.0°C – 41.0°C (40.0°C nominal)
- DVM MED Temperature Reading: 0.395V – 0.415V (0.405V nominal)

3. If necessary, slowly readjust R105 (hose end M) for a TA reading of 39.8°C – 40.2°C (40.0°C nominal). Refer to Figure 3-5 for the locations. Wait until the readings on the TA stabilize.

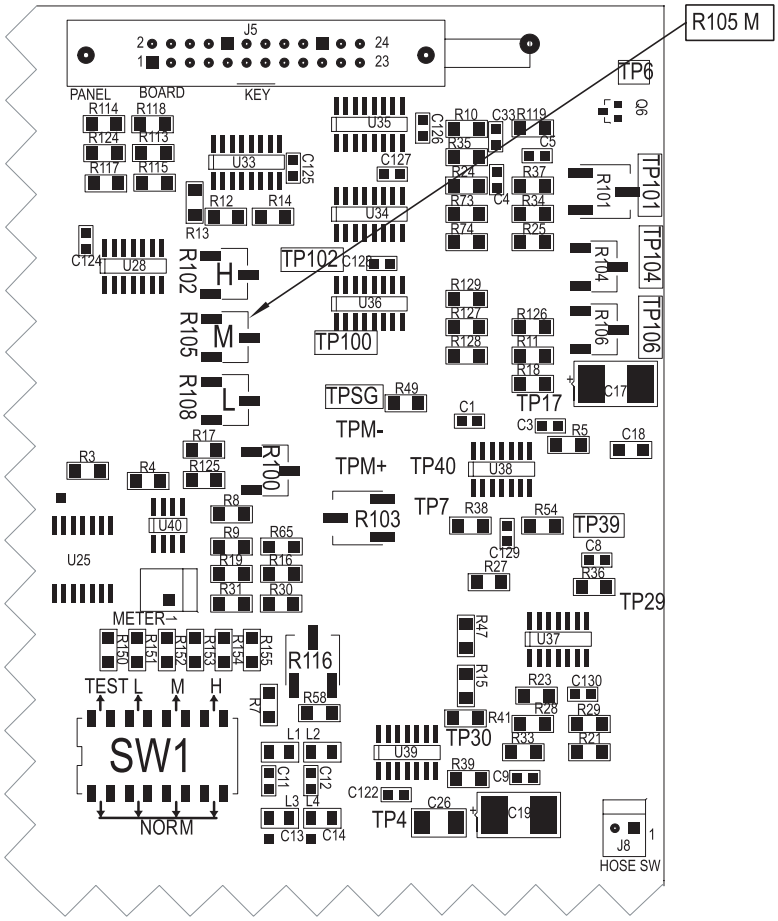


Figure 3-5 Location for R105

4. Record the MED temperature readings in items 8 through 10 on the Checklist.

Test 5: LO Temperature Test

1. Press the LO button

, and allow the temperature to stabilize for at least 5 minutes.
2. After the temperature has stabilized, verify that the LO temperature readings appear as follows:

- TA LO Temperature Reading: 35.0°C – 37.0°C (36.0°C nominal)
- Device LO Temperature Display: 35.0°C – 37.0°C (36.0°C nominal)
- DVM LO Temperature Reading: 0.355V – 0.375V (0.365V nominal)

3. If necessary, slowly readjust R108 (hose end L) for a TA reading of 35.8°C – 36.2°C (36.0°C nominal). Refer to Figure 3-6 for the location. Wait until the readings on the TA stabilize.

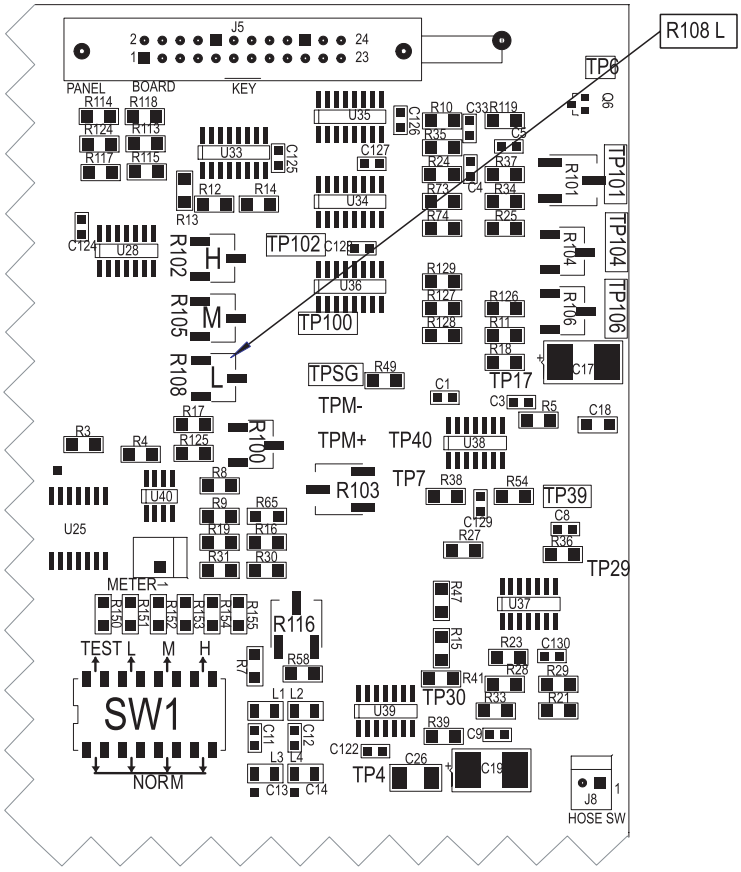


Figure 3-6 Location for R108

4. Record the LO temperature readings in items 11 through 13 on the Checklist.

Test 6: LO OverTemp and UnderTemp Test

1. Press the OFF button and then press the ON button. The device will restart and proceed through the self-test sequence.
2. If the device is hot, let it cool to approximately 30°C before proceeding.
3. Press and hold the LO button

on the front panel for approximately 8 seconds, until the LO button LED starts to flash.
4. As the temperature increases, verify that the following events occur:

- Between 32°C and 34°C, the UT LED ( )stops flashing.
- Between 38°C and 40°C, the OT alarm sounds, the OT LED ( ) lights, the blower stops, and the control panel displays the temperature at which the OT alarm was activated.

5. Check **Pass** for item 14, and record the temperature reading from the control panel in item 15 on the Checklist.

Note: *If the expected test events were not obtained, proceed to Test 10 in this test sequence to perform the readjustment procedures.*

Test 7: MED OverTemp and UnderTemp Test

1. Press the OFF button and then press the ON button. The device will restart and proceed through the self-test sequence.
2. If the device is hot, let it cool to approximately 35°C before proceeding.
3. Press and hold the MED button

on the control panel for approximately 8 seconds, until the MED button LED starts to flash.
4. As the temperature increases, verify that the following events occur:

- Between 36°C and 38°C, the UT LED ( ) stops flashing.
- Between 42°C and 44°C, the OT alarm sounds, the OT LED ( ) lights, the blower stops, and the control panel displays the temperature at which the OT alarm was activated.

5. Check **Pass** for item 16, and record the temperature reading from the control panel in item 17 on the Checklist.

Note: *If the expected test events were not obtained, proceed to Test 10 in this test sequence to perform the readjustment procedures.*

Test 8: HI OverTemp and UnderTemp Test

1. Press the OFF button and then press the ON button. The device will restart and proceed through the self-test sequence.
2. If the device is hot, let it cool to approximately 40°C before proceeding.
3. Press and hold the HI button on the control panel for approximately 8 seconds, until the HI button LED starts to flash.
4. As the temperature increases verify that the following events occur:

- Between 40°C and 42°C, the UT LED ( ) stops flashing.
- Between 46°C and 48°C, the OT alarm sounds, the OT LED ( ) lights, the blower stops, and the control panel displays the temperature at which the OT alarm was activated.

5. Check **Pass** for item 18, and record the temperature reading from the control panel in item 19 on the Checklist.

   Note: *If the expected test events were not obtained, proceed to Test 10 in this test sequence to perform the readjustment procedures.*

Test 9: Ambient OverTemp Test

1. Press the OFF button and then press the ON button. The device will restart and proceed through the self-test sequence.
2. If the device is hot, let it cool to approximately 44°C before proceeding.
3. Press and hold the AMB button on the control panel until the AMB button LED starts to flash.
4. As the temperature increases, verify that the following events occur:

- Between 46°C and 48°C, the OT alarm sounds, the OT LED ( ) lights, the blower stop, and the control panel displays the temperature at which the OT alarm was activated.

5. Record the temperature reading from the control panel in item 20 on the Checklist.

   Note: *If the expected test events were not obtained, proceed to Test 10 in this test sequence to perform the readjustment procedures.*

6. Press the OFF button.

Test 10: OverTemp and UnderTemp Readjustment

Note: *The following readjustment procedure is necessary only if one or more of the previous OverTemp or UnderTemp test results from Tests 6-9 were out of tolerance.*

Note: *After completing the following readjustment procedure, you must repeat all of the OverTemp and UnderTemp tests (Tests 6 to 9).*

1. Disconnect J4 and J7 from the Control Electronic Assembly. Refer to Figure 3-3 for the locations.
2. Set DIP switches on SW1 as follows; slide switch 1 to the TEST position and switch 4 to the H position

. Refer to Figure 3-7 for the position of SW1 on the electronic assembly.

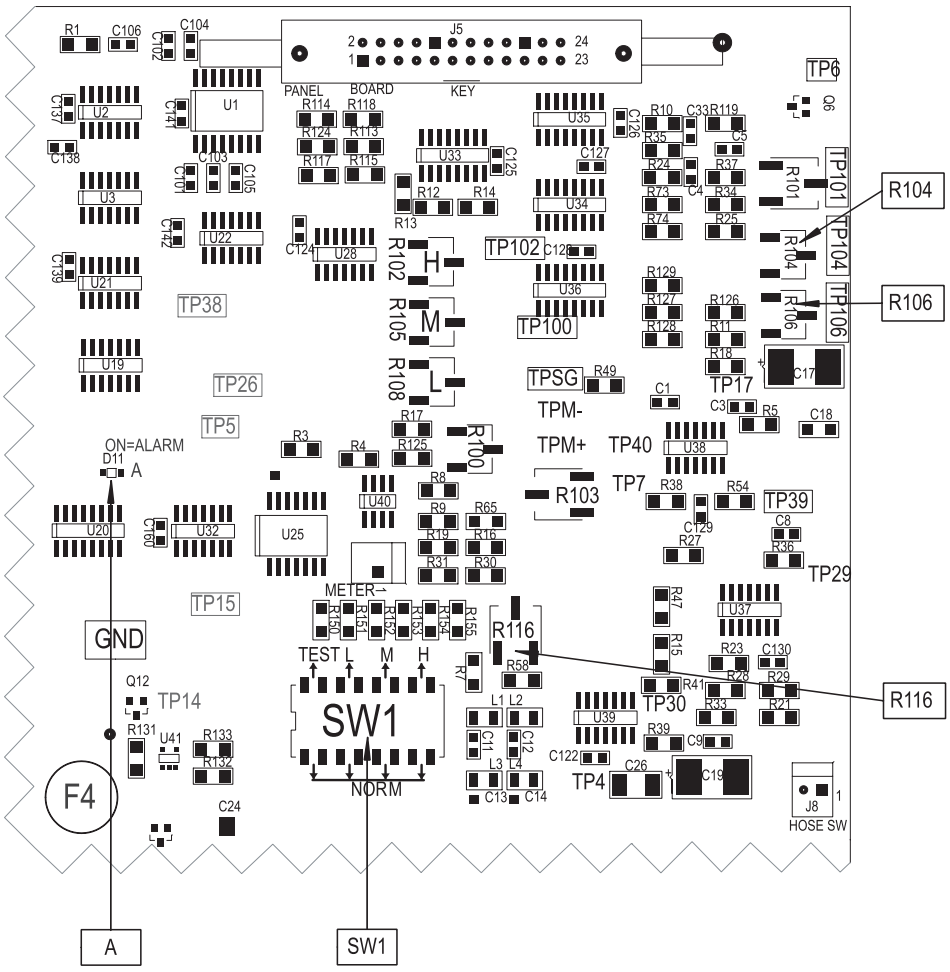


Figure 3-7 Locations for R104, R106, R116, A LED, and SW1

3. Press the ON button , then press the HI button

.
4. Adjust R116 until the DVM reads 0.473V – 0.477V (0.475V nominal).

5. Adjust R104 until the “A” LED (at position D11 in the center of the Control Electronic Assembly) just turns OFF (turn counterclockwise if the “A” LED is already turned ON).
6. Adjust R116 counterclockwise until the DVM reads 0.413V – 0.417V (0.415V nominal).
7. Adjust R106 (UT) until the UnderTemp LED ( ) on the control panel just stops flashing (turn counterclockwise if the LED is flashing). Refer to Figure 3-7 for the location on the electronic assembly.
8. Press the OFF button .
9. Reconnect J4 and J7 to the Control Electronic Assembly.
10. Reset the DIP switches on SW1 to the NORM positions

.
11. Repeat all OverTemp and UnderTemp Tests (Tests 6-9) while re-recording test results in items 14-20 on the Checklist.

Test 11: Temperature DownStep Alarm Delay Check

1. Disconnect J4 and J7 from the Control Electronic Assembly. Refer to Figure 3-3 for the locations on the electronic assembly.
2. Set DIP switch 4 on SW1 to the H position

. Refer to Figure 3-7 for the position of SW1 on the electronic assembly.
3. Turn R116 on the Control Electronic Assembly to the **center** of its rotation. Refer to Figure 3-7 for the locations on the electronic assembly. The DVM should read approximately 0.42V.
4. Press the ON button . The motor will not run.
5. Press the HI button

on the control panel. Start the stopwatch and press the LO button

at the same time.
6. Measure the time until the OT LED ( ) turns ON and the alarm sounds. The stopwatch should read between 60 and 90 seconds.
7. Record the measured time in item 21 on the Checklist.
8. Press the OFF button .
9. Reconnect J4 and J7 to the electronic assembly.
10. Reset DIP switch 4 on SW1 to the NORM position

.

Test 12: Fire Safety Thermostat Function Test

1. Check that the DIP switches are in the NORM position . Refer to Figure 3-7 for the position of SW1 on the electronic assembly.
2. Remove TA and completely plug the end of the hose at the elbow, using a hose holder so that there is no airflow.
3. Press the ON button .
4. Start the stopwatch and press and hold the HI button on control panel for approximately 8 seconds, until the HI button LED starts to flash.

   Note: *If the next step takes longer than 130 seconds maximum, or if there is smoke or a burning smell, press the OFF button* *and disconnect power immediately!*
5. Measure the time until the thermostat turns off. Stop the stopwatch when the Disconnect LED ( ) lights and the alarm sounds. The motor does not stop.
6. Record the stopwatch time in item 22 on the Checklist.
7. Press the OFF button .
8. Unplug the hose and disconnect the hose from the back of the device to allow cool air inside to help reset thermostat. After approximately 1 minute, reconnect the hose.
9. Press the ON button . Verify that the device completes self-test and functions normally. Check **Pass** for item 23 on the Checklist.

Test Completion

Shut Down the Instrument

1. Press the OFF button and unplug the device from the power outlet.
2. Verify that the DIP switches are in the NORM position . Refer to Figure 3-7 for the position of SW1 on the electronic assembly. Check **Pass** for item 24 on the Checklist.
3. Before closing the enclosure, disconnect grounding clip lead from chassis to the motor mounting plate if installed.
4. Reinstall the top of the enclosure. Refer to the *Reinstall the Enclosure Top* procedure in Chapter 4.

Determine Instrument Disposition

Review all of the entries on the Checklist. If the entries show that the device is in tolerance with all required test parameters, the device is in calibration and all safety features are functional.

Note: *Perform all applicable electrical safety tests as required per institutional procedure or protocols before returning the device to patient use. These tests include, but are not limited to, leakage current and ground bond test. Perform these tests according to methods and pass/fail criteria described in UL 2601-1 or EN 60601-1.*

WARNING!

- **Grounding reliability can only be achieved when the Mains power cords are connected to a properly grounded receptacle. Risk of electrical shock exists if the equipment is not connected to a properly grounded receptacle resulting in death or serious injury to the patient or user.**

If the test entries show that the device is not in tolerance with all required test parameters, do not use the device. Contact Smiths Medical ASD Technical Service Department or Smiths Medical ASD.

4 Component Removal and Replacement

This chapter contains procedures to remove and replace various parts for the EQUATOR® Convective Warmer.

Each procedure outlined in the following pages references an exploded-view diagram that supplements the procedural steps. The diagrams illustrate all of the components in the procedure and show the relationships of how each item fits into the component or module being replaced. Refer to Figures D-1 and D-2 in *Appendix D* to view a more complete illustration of the enclosure base and top.

Note: *Always perform the Functional Test and Calibration Procedure after performing repairs to the EQUATOR® Convective Warmer and before returning the device to the clinical area. Improper repairs may result in serious injury to the patient, damage to the device, or device malfunction.*

WARNING!

- **The EQUATOR® Convective Warmer warming unit must be calibrated by Smiths Medical ASD or Smiths Medical ASD authorized personnel.**

Tools and Equipment Required

The following tools and equipment are needed to perform the removal and replacement procedures:

- Loctite 495 Super Bonder
- Loctite 222MS
- 5/32” Allen wrench
- 3/8” spin-tite or socket wrench
- Phillips-head and flat-head screwdrivers

Open the Enclosure

Use the following procedure to open the enclosure to access internal components that need removal and replacement.

Remove the Enclosure Top

1. Disconnect the power cord from the electrical outlet and from the rear of the device. Remove the device from pole if pole mounted.
2. Lay the device on its side and loosen the four slotted-head, captive-corner screws. Refer to Figure 4-1.
3. Stand the device on its base with the control panel facing to the front.
4. Gently lift the top off and lay it upsidedown to the right of the base. Be careful not to dislodge any cables.

   Note: *High voltage in excess of 200VDC exists immediately after the device is turned off. The voltage exists on the motor driver electronic assembly as a charge on the two large capacitors at the top of the electronic assembly. It dissipates with time.*

WARNING!

- **Electrocution Hazard. There are no user-serviceable parts inside the enclosure. Only competent personnel knowledgeable in the safety procedures required for servicing live Mains parts shall be allowed to open the enclosure.**

---

5. Open the Kurly-Lok wire anchor to release the blue twisted wires and the black cable.

   Note: *Be careful not to stress the transformer (T2) on the Control Electronic Assembly, especially when disconnecting the quick connects in the blue wires.*

6. Release the cable to J6 from the wire clip.

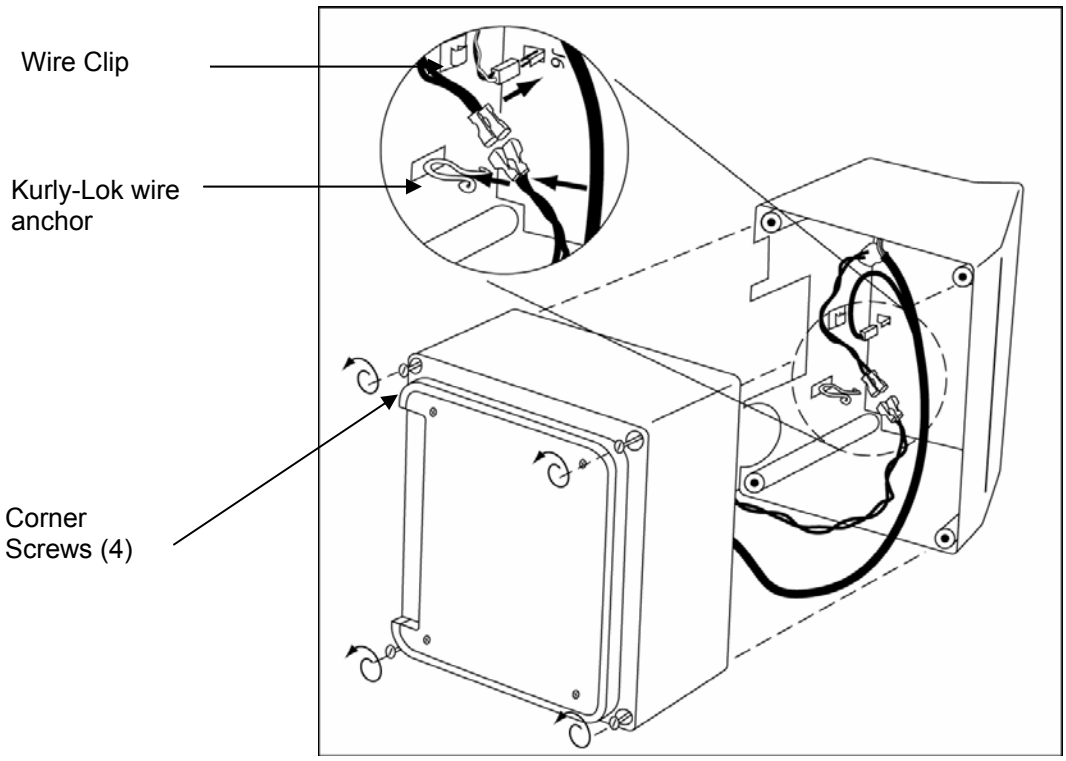


Figure 4-1 Enclosure Exploded-View Diagram

Reinstall the Enclosure Top.

Note: *Remove the motor mounting plate grounding clip if installed.*

1. If the Kurly-Lok anchor or the wire clip has become unstuck, replace or re-stick the anchor(s) using Loctite 495 Super Bonder. Place the Kurly-Lok anchor next to the hose thermistor input connector. Refer to Figure A-4 in *Appendix A* to see placement of the anchors.
2. From the large black cable, place the small cable that connects to J6, into the wire clip where it separates from the black cable. Place the blue twisted wires and the large black cable into the Kurly-Lok wire anchor and twist the ends to capture the wires.
3. With the device standing on its base, gently place the top on the base. The top should fit onto base without forcing. Forcing usually indicates interference of cables between the motor and the Control Electronic Assembly.
4. Lay the device on its side or hang each corner off the side of the working surface and tighten the four corner screws diametrically.
5. Reconnect the power cord to the electrical outlet and to the rear of the device.

Replace the Motor Driver Electronic Assembly

Note: *The Motor Driver Electronic Assembly is the large electronic assembly mounted vertically and to the left of the motor.*

Note: *Refer to the Interconnect Schematic in Appendix E for cable connections.*

1. Disconnect the power cord from the electrical outlet and from the rear of the device.
2. Remove the enclosure top. Refer to the *Open the Enclosure* procedure described at the beginning of this chapter.

   Note: *High voltage in excess of 200VDC exists immediately after the device is turned off. The voltage exists on the motor driver electronic assembly as a charge on the two large capacitors at the top of the electronic assembly. It dissipates with time.*

WARNING!

- **Electrocution Hazard. There are no user-serviceable parts inside the enclosure. Only competent personnel knowledgeable in the safety procedures required for servicing live Mains parts shall be allowed to open the enclosure.**

---

3. Open the Kurly-Lok wire anchor to release the blue twisted wires and the black cable.
4. Disconnect the AC Mains cable at P4 on the Motor Driver Electronic Assembly. Refer to Figure 4-2.
5. Remove the two nylon screws (and nuts) holding the Motor Driver Electronic Assembly to the back shield.

   Note: *The back shield does not need to be removed to remove the Motor Driver Electronic Assembly.*
6. With a 3/8” spin-tite or socket, remove the locknut from the other board mount bracket and remove the ring terminal. Removal of the nylon nut just above the locknut may be necessary to access the locknut.
7. Lift the electronic assembly straight up.
8. Disconnect the motor cable at the in-line connector and remove the electronic assembly.
9. Remove the electronic assembly from its protective shield, carefully observing the high voltage **WARNING** stated above.
10. Install the new driver electronic assembly.

11. Reassemble the device by performing the appropriate steps in reverse order.

    Note: *Connect the motor cable at the in-line connector before inserting the electronic assembly.*

12. Check the DIP switches on the driver electronic assembly, if installed, to verify the correct settings. Refer to the default settings in Figure A-3 in *Appendix A*.

13. The air speed may have to be readjusted. Refer to *Test 3: HI Temperature Test* procedure in Chapter 3 if necessary.

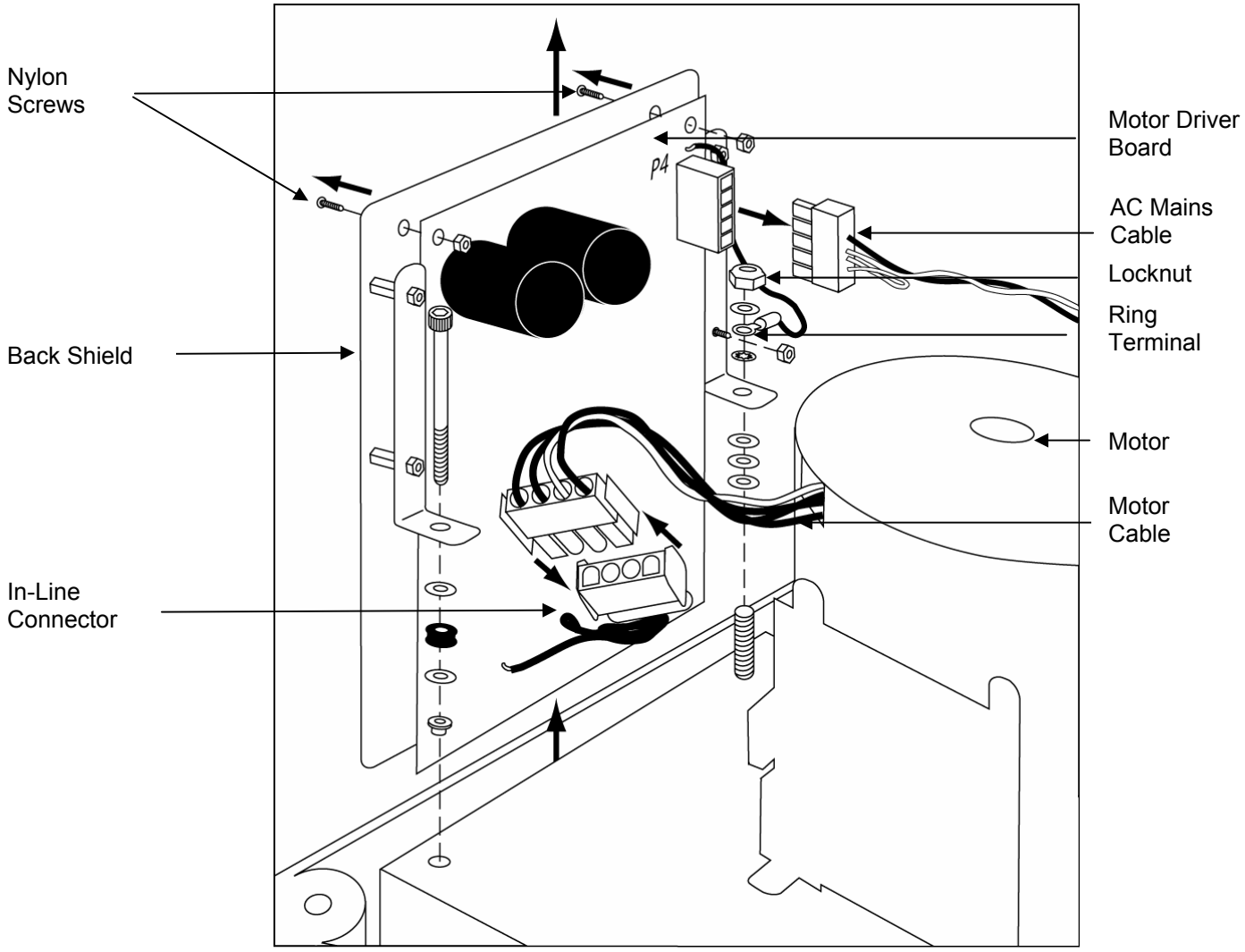


Figure 4-2 Motor Driver Electronic Assembly Exploded-View Diagram

Replace the Motor

1. Disconnect the power cord from the electrical outlet and from the rear of the device.
2. Remove the enclosure top. Refer to the *Open the Enclosure* procedure described at the beginning of this chapter.
3. Open the Kurly-Lok wire anchor to release the blue twisted wires and the black cable.
4. Disconnect the cable at J2 on the power supply assembly and at J4 on the Mains Electronic Assembly. Refer to Figure 4-3.

   Note: *Refer to Figure E-4 in Appendix E for cable connections.*
5. Disconnect the quick connects in the blue wires.

   Note: *Be careful not to stress the transformer (T2) on the Control Electronic Assembly when disconnecting the quick connects in the blue wires.*
6. Loosen the two screws at the end of J2 on the Mains Electronic Assembly and remove the plug.
7. Loosen the screws from pin 1 and pin 8 on J2 and disconnect the two heater wires.
8. Remove the screw on the upper-right corner of the power supply assembly and remove the ring terminal.
9. Remove the four screws attaching the Mains Electronic Assembly to the stand-offs, and lift the electronic assembly away to allow access to the cap screw in the rear of the motor mounting plate.
10. With a 5/32” Allen wrench, remove the three cap screws in the motor mounting plate.

    Note: *Some versions of the device may have two screws that secure the air outlet to the motor mounting plate.*
11. If installed, remove the two screws through the motor mounting plate at the air outlet. Refer to Figure 4-3 for their location.
12. Lift the motor mount assembly up from the plenum, tilt the assembly so the motor driver electronic assembly clears its cavity, and remove.

    Note: *Guide the heater wires through the grommet on the motor mounting plate.*
13. Rotate the impeller and check for any damage to the blades. If the impeller is damaged, replace it.

    Note: *Before removing the impeller, measure the distance between the impeller and the motor mounting plate. With the motor facing down,*

measure the distance from the motor mounting plate to the bottom of the impeller (approximately 1.5"). When you reinstall the impeller, you must advance it on the shaft to the same distance.

14. Remove the impeller from shaft by wedging two screw drivers under opposite sides and prying the impeller evenly off the shaft.
15. Remove the four nuts that hold the motor to the mounting plate.
16. Lift the motor out and disconnect the motor cable from the Motor Driver Electronic Assembly at the in-line connector. Refer to Figure 4-2 to see the in-line connector.

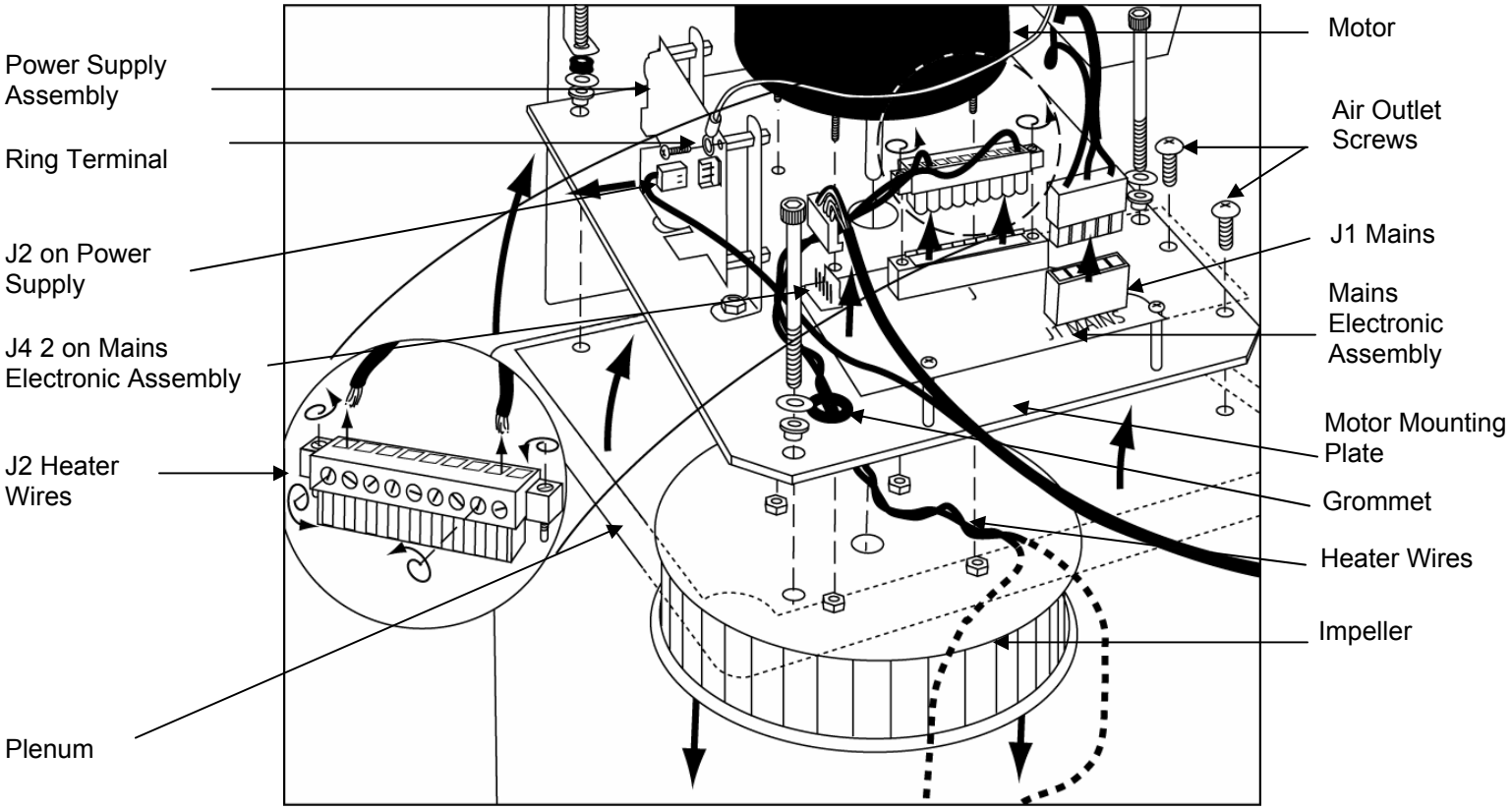


Figure 4-3 Motor Exploded-View Diagram

17. Install the new motor.
18. Reassemble the device by performing the appropriate steps in reverse order.

    Note: *When reinstalling the impeller, observe the following:*

    - Align the motor shaft and impeller flats.
    - With the motor facing down, slide the impeller onto the shaft so the distance between the bottom of the impeller and the motor mounting plate is the same as it was when removed.
    - Spin the impeller to be sure it spins true. If it doesn't, adjust the impeller on the shaft until the impeller blades spin true.

Note: *When reinstalling the motor mount assembly, insert the heater wires through the grommet on the motor mounting plate.*

Replace the Impeller

Replacing the impeller requires removal of the motor mount assembly. The impeller is located under the motor mounting plate.

1. Perform the *Replace the Motor* procedure to remove the motor mount assembly, but do not remove the motor from the mounting plate.
2. With the motor mount assembly removed, measure the distance between the impeller and the motor mounting plate. With the motor facing down, measure the distance from the motor mounting plate to the bottom of the impeller (approximately 1.5”). When you reinstall the impeller, you must advance it on the shaft to the same distance.
3. Remove the impeller from the shaft by wedging two screwdrivers under opposite sides and prying the impeller evenly off the shaft.
4. Install the new impeller. Observe the following:
   - Align the motor shaft and impeller flats.
   - With the motor facing down, slide the impeller onto the shaft so the distance between the bottom of the impeller and the motor mounting plate is the same as it was when removed.
   - Spin the impeller to be sure it spins true. If it doesn’t, adjust the impeller on the shaft until the impeller blades spin true.
5. Reassemble the device by performing the appropriate steps in reverse order.

Replace the Heater

Replacing the heater requires removal of the motor mount assembly. The heater is located under the motor mounting plate.

1. Perform the *Replace the Motor* procedure to remove the motor mount assembly, but do not remove the motor from the mounting plate or the impeller from the motor.
2. With the motor mount assembly removed, lift out the plenum. Be sure to guide the heater wires through the exit hole in the plenum.
   Refer to Figure 4-4.

   Note: *Some plenums have a separate air outlet. Remove both pieces if this is the case.*

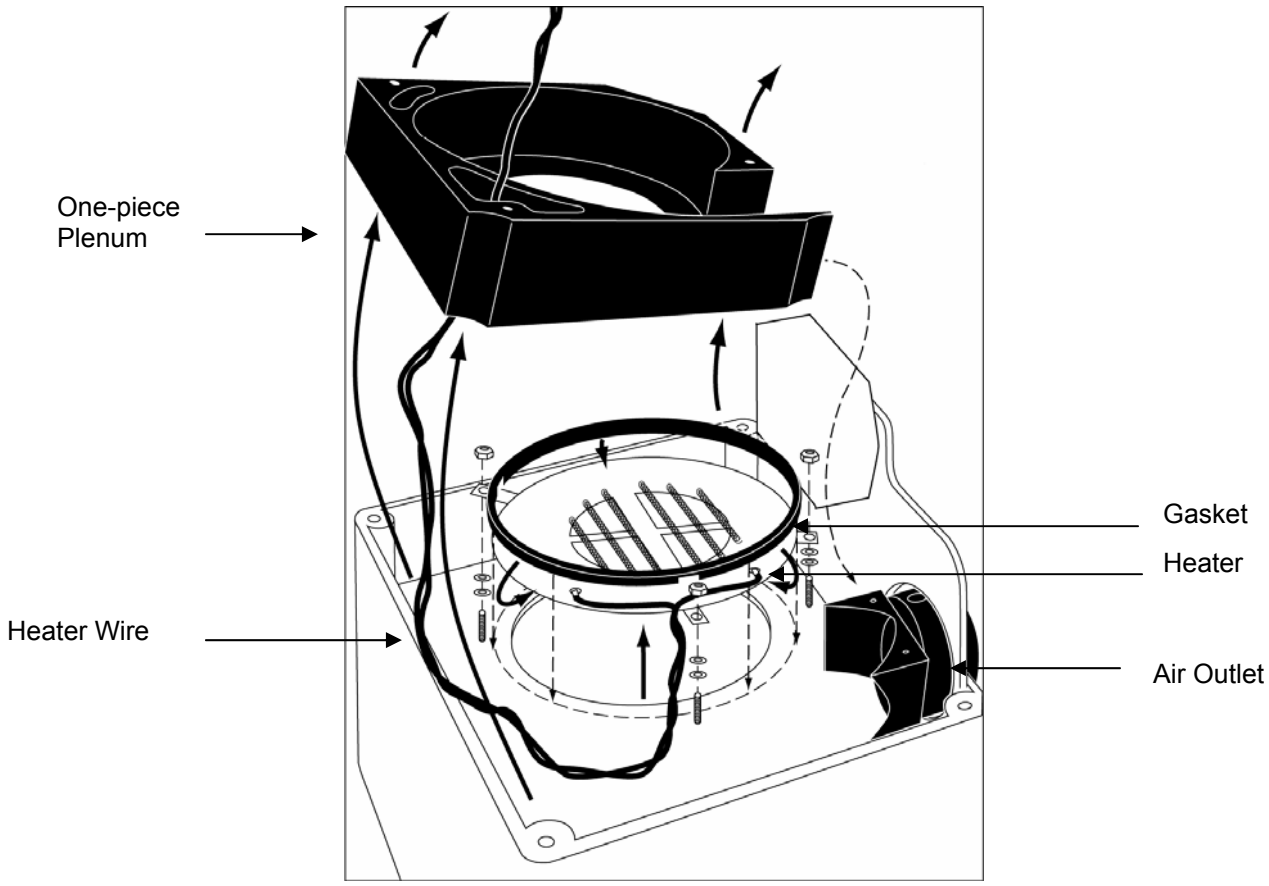


Figure 4-4 Heater Exploded-View Diagram

3. Remove the three nuts from the studs holding the heater to the chassis.
4. Remove heater and the gasket.
5. Attach the new gasket around the heater. Be sure to align the three slits in the gasket to the three brackets on the heater.
6. Guide the heater wires through the slit in the gasket closest to the exit hole in the plenum.
7. Twist the heater wires approximately one twist every inch (2.5 cm).
8. Insert the two thick washers onto each stud, if removed.
9. Orient and insert the heater onto the chassis studs.
10. Reassemble the device by performing the appropriate steps in reverse order.

    Note: *Be sure to guide the heater wires through the exit hole in the plenum during reassembly.*

11. Test for smooth and proper operation of the microswitch after assembly.

Replace the Hose Microswitch Assembly

1. Disconnect the power cord from the electrical outlet and from the rear of the device.
2. Remove the enclosure top. Refer to the *Open the Enclosure* procedure described at the beginning of this chapter.
3. Remove the four screws attaching the Mains Electronic Assembly to the stand-offs and lift the Mains Electronic Assembly away from the screws on the microswitch assembly. Refer to Figure 4-5.

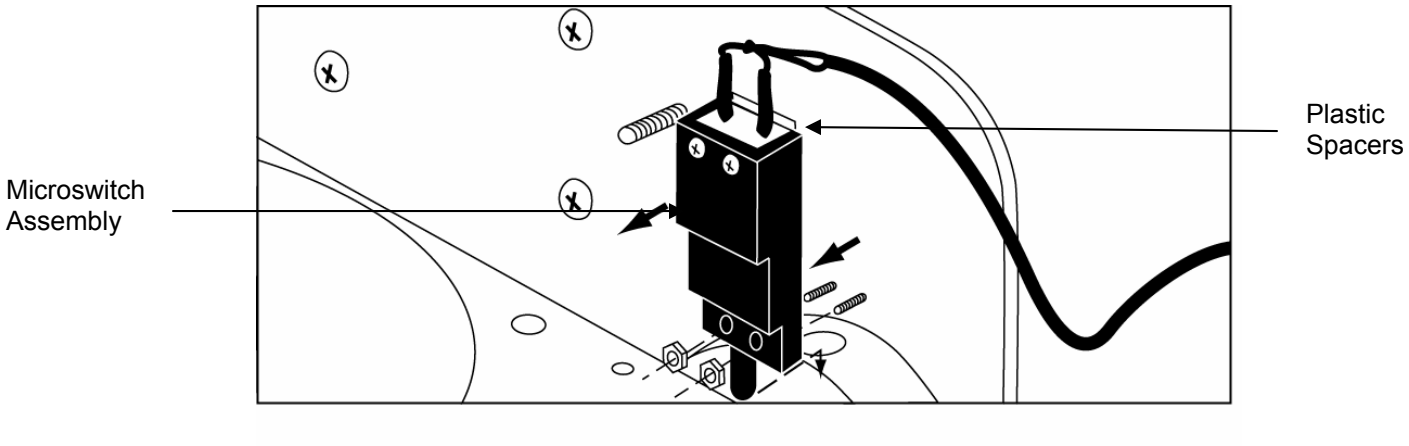


Figure 4-5 Hose Microswitch Assembly Exploded-View Diagram

4. Remove the two small nuts securing the microswitch assembly to the studs. Remove the microswitch assembly.
5. When reinstalling the microswitch assembly to the studs, be sure to use a thread-locking adhesive compatible with plastics; e.g., Loctite 222MS.
6. Install the new microswitch assembly.
7. Be sure the attachment nuts do NOT touch the motor mounting plate.
8. Reassemble the device by performing the appropriate steps in reverse order.
9. Test for smooth and proper operation of the microswitch after assembly.

Replace the Air Outlet

Replacing the air outlet requires removal of the motor mount assembly. The air outlet is located under the motor mount assembly.

1. Perform the *Replace the Motor* procedure to remove the motor mount assembly, but do not remove the motor from the mounting plate or the impeller from the motor.

2. With the motor mount assembly removed, remove the hose microswitch assembly. Refer to the *Replace the Hose Microswitch Assembly* procedure described in this chapter.
3. Remove the air outlet by sliding it into the plenum. Refer to Figure 4-7.

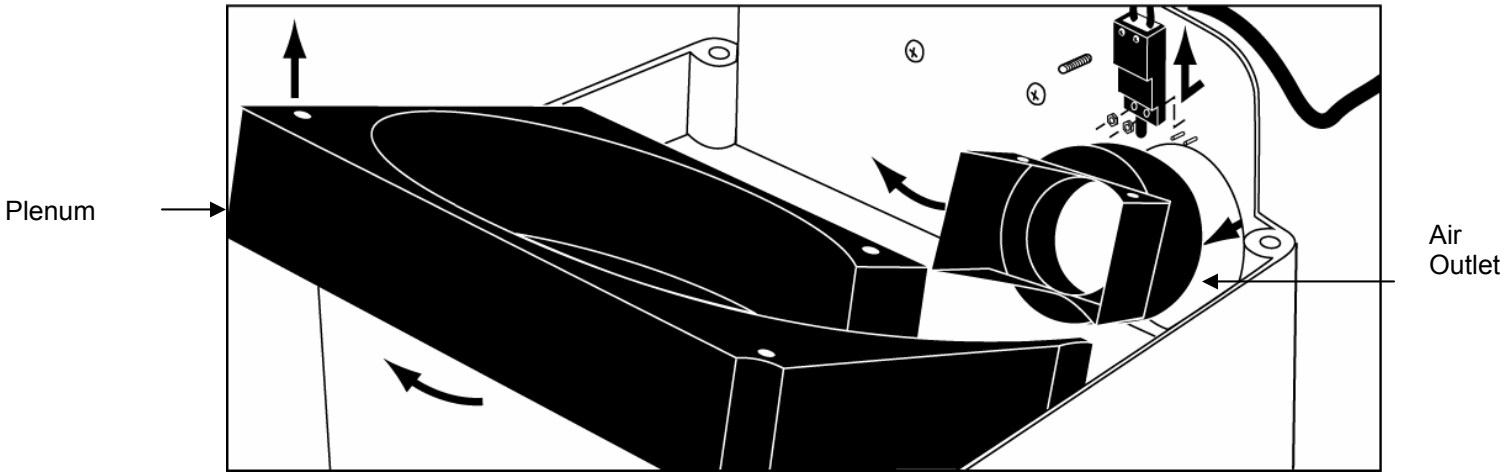


Figure 4-7 Air Outlet Exploded-View Diagram

4. Install the new air outlet. Be sure the holes are to the top on the air outlet.
5. Reassemble the device by performing the appropriate steps in reverse order.
6. Hold the air outlet in position while testing the microswitch actuation with a finger. The switch should actuate easily and freely without having to press the finger flush to the outlet.

Replace the Pole Clamp

1. Perform the *Replace the Motor* procedure to remove the motor mount assembly, but do not remove the motor from the mounting plate or the impeller from the motor.
2. Remove the four screws retaining the pole clamp to the rear chassis, and remove the clamp. Refer to Figure 4-8.
3. Reassemble the device by performing the appropriate steps in reverse order.

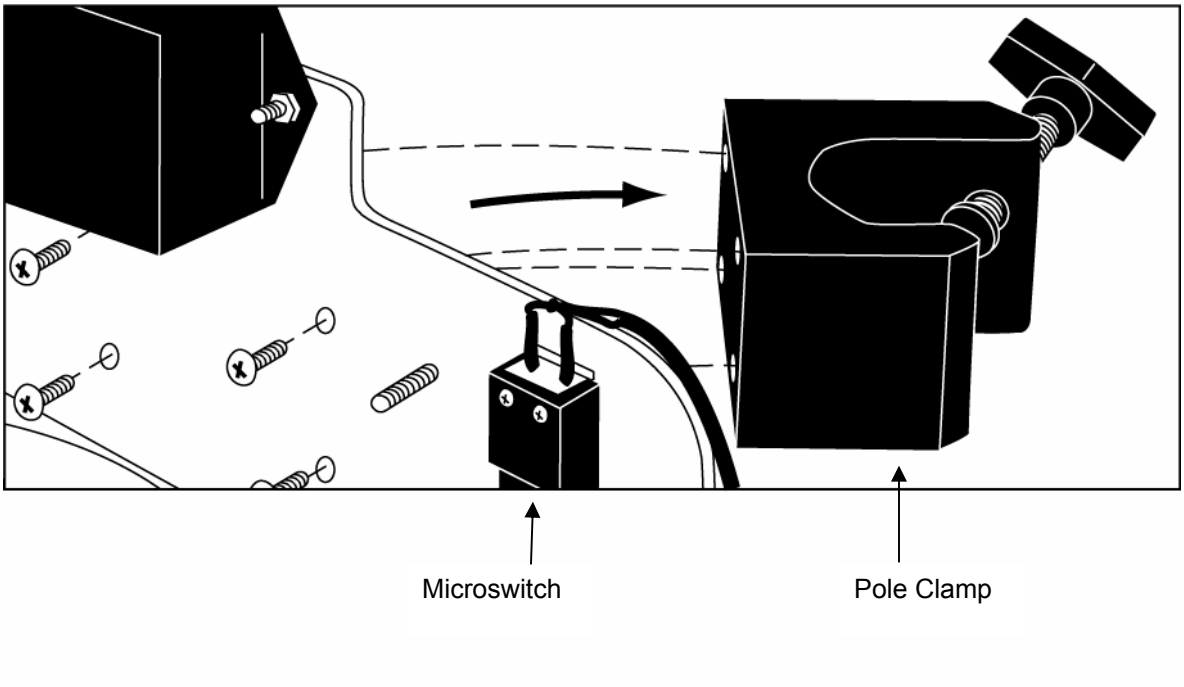


Figure 4-8 Pole Clamp Exploded-View Diagram

Replace the Control Panel

1. Disconnect the power cord from the electrical outlet and from the rear of the device.
2. Remove the enclosure top. Refer to the *Open the Enclosure* procedure described at the beginning of this chapter.
3. Open the Kurly-Lok wire anchor holding the cables to the rear of the enclosure and remove the J6 cable from the wire clip.
4. Disconnect all cables leading from the base to the Control Electronic Assembly inside the top cover at the Control Electronic Assembly. Refer to Figure 4-9.

   Note: *Be careful not to stress the transformer (T2) on the Control Electronic Assembly, especially when disconnecting the quick connects in the blue wires.*

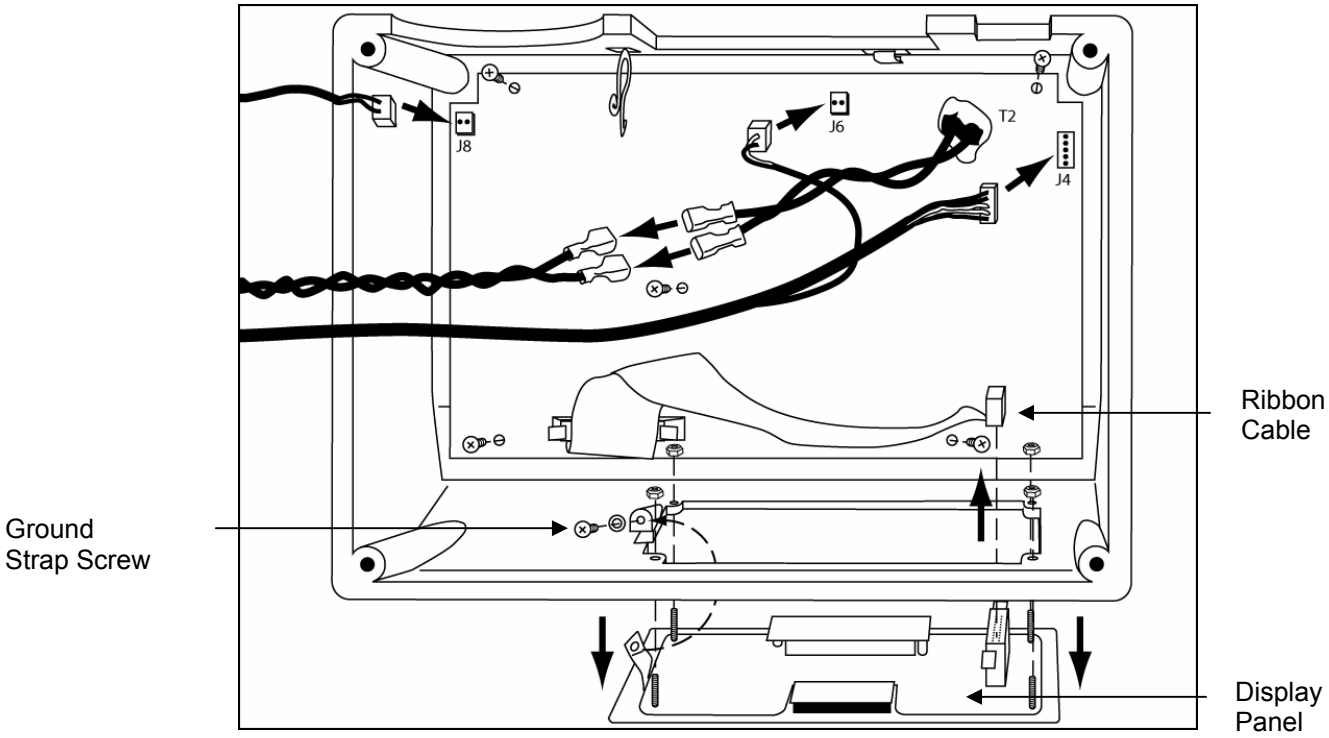


Figure 4-9 Control Panel Exploded-View Diagram

5. Remove ribbon cable from the panel board.
6. Remove the five screws securing the Control Electronic Assembly to its mount and remove it for better access to nuts on the panel board.
7. Remove the four nuts that secure the panel board.
8. Remove the panel electronic assembly ground strap screw.

   Note: *The edge of the panel board is sealed with double-sided tape to the face of the enclosure top.*
9. Begin at a corner and press the panel board firmly and evenly from the inside until the tape releases.
10. Clean the mating surface of any residual tape adhesive to maintain the IPX rating.
11. Remove tape backing from new panel board; align mounting studs in holes and press into place.
12. Secure with four locknuts. Re-install the panel electronic assembly ground strap to the post, shiny side down.
13. Firmly press around the entire sealing surface to seal the tape to maintain IPX rating.
14. Reinstall Control Electronic Assembly if removed.
15. Reconnect all cables. Refer to Figure E-4 in *Appendix E* for all cable connections.

16. Reinstall the enclosure top. Refer to the *Reinstall the Enclosure Top* procedure described earlier in this chapter.

Replace the Power Supply Assembly

The power supply assembly sits just in front of motor. Refer to Figure 4-10.

1. Disconnect the power cord from the electrical outlet and from the rear of the device.
2. Remove the enclosure top. Refer to the *Open the Enclosure* procedure described at the beginning of this chapter.
3. Release the cable to J6 from the wire clip.
4. Remove the cable at J1 and J2 on the power supply assembly.
5. Remove the screw at the upper-right corner and remove the ring terminal.
6. Remove the remaining three corner screws securing the power supply to its standoffs, and remove the power supply.

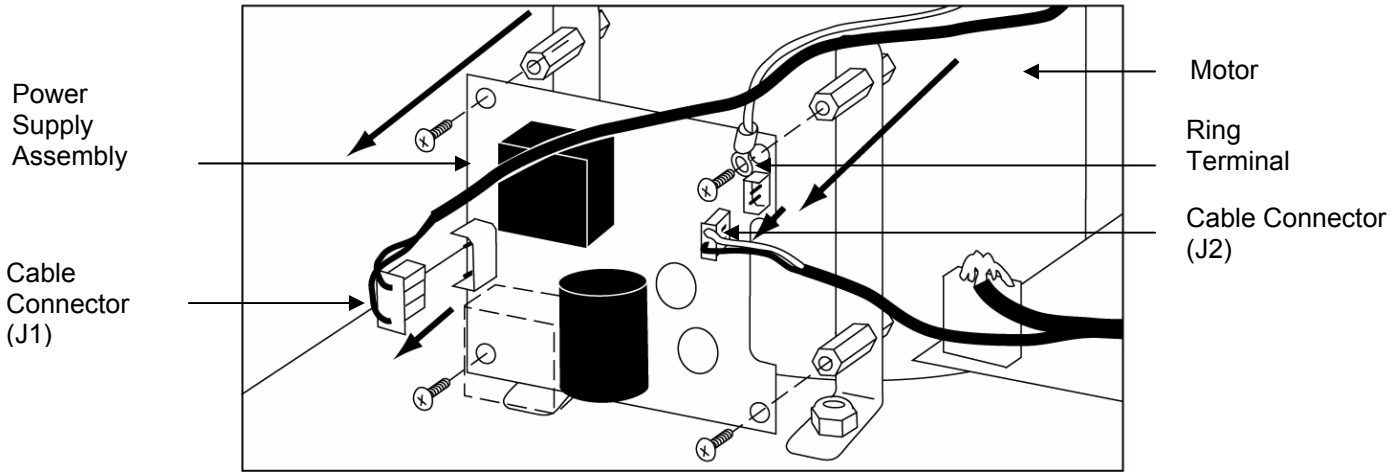


Figure 4-10 Power Supply Exploded-View Diagram

7. Install the new power supply assembly.
8. Orient the board so that the cable connector (J1) is on the left and the connector (J2) is in the upper-right corner.
9. Reassemble the device by performing the appropriate steps in reverse order.

A Reference Diagrams

Appendix A contains the following reference diagrams:

- Mains Electronic Assembly
- Control Electronic Assembly
- Motor DIP Switch Settings & Speed Adjustment Potentiometer
- Enclosure Top Cables
- Enclosure Base Wiring

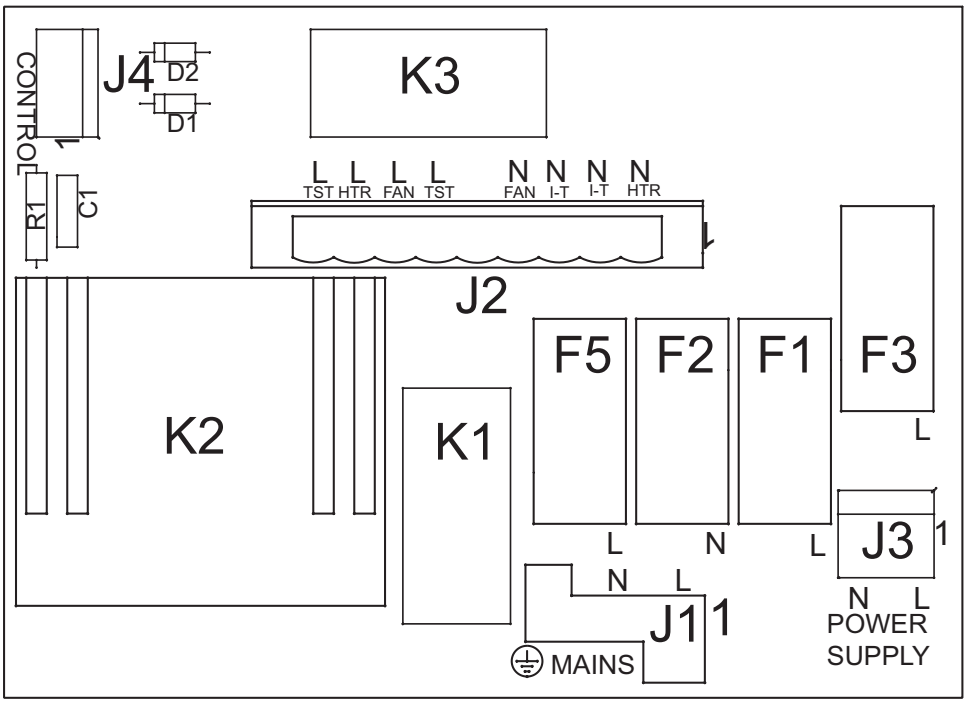


Figure A-1 Mains Electronic Assembly

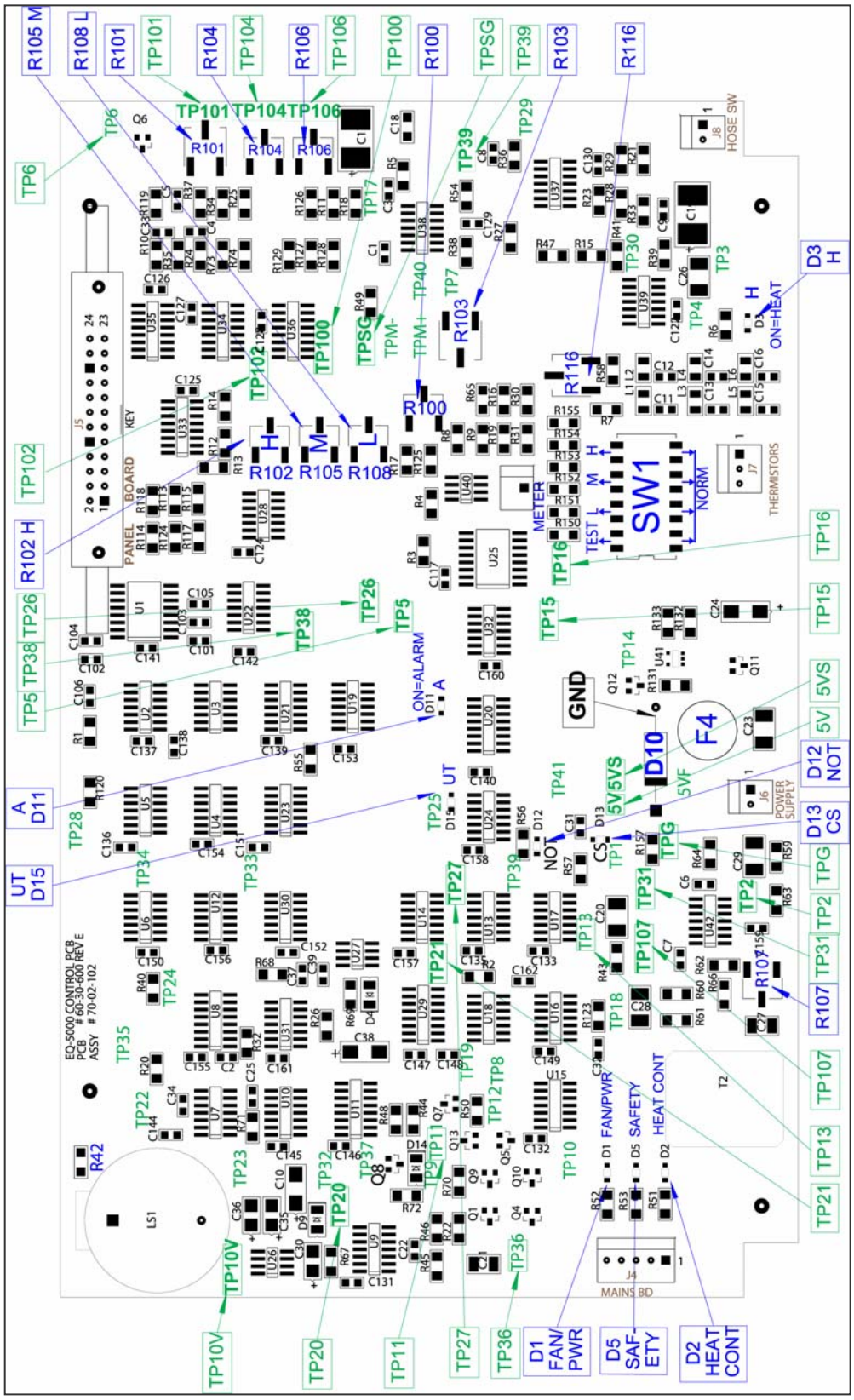


Figure A-2 Control Electronic Assembly

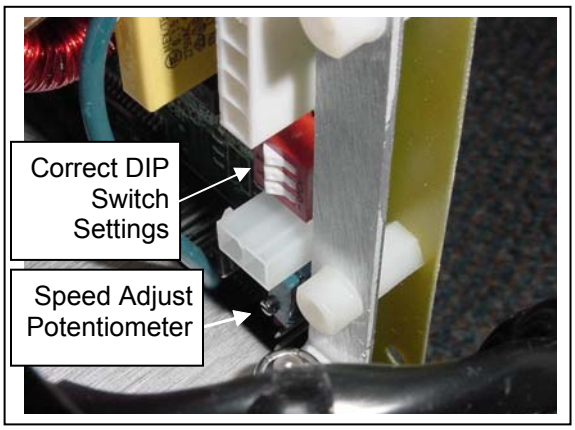


Figure A-3 DIP Switch Settings and Speed Adjust Potentiometer on the Motor Driver Electronic Assembly

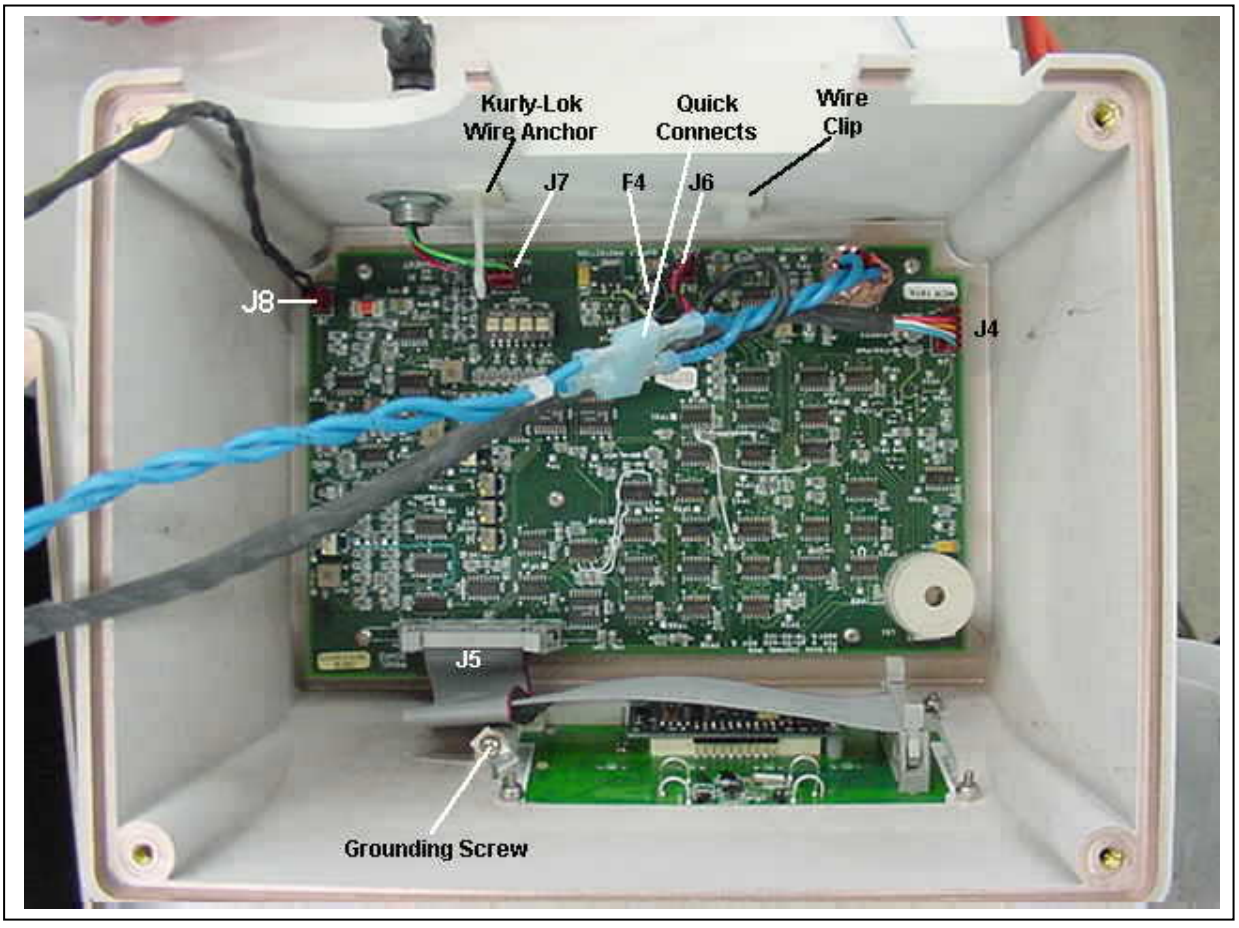


Figure A-4 Enclosure Top Cables

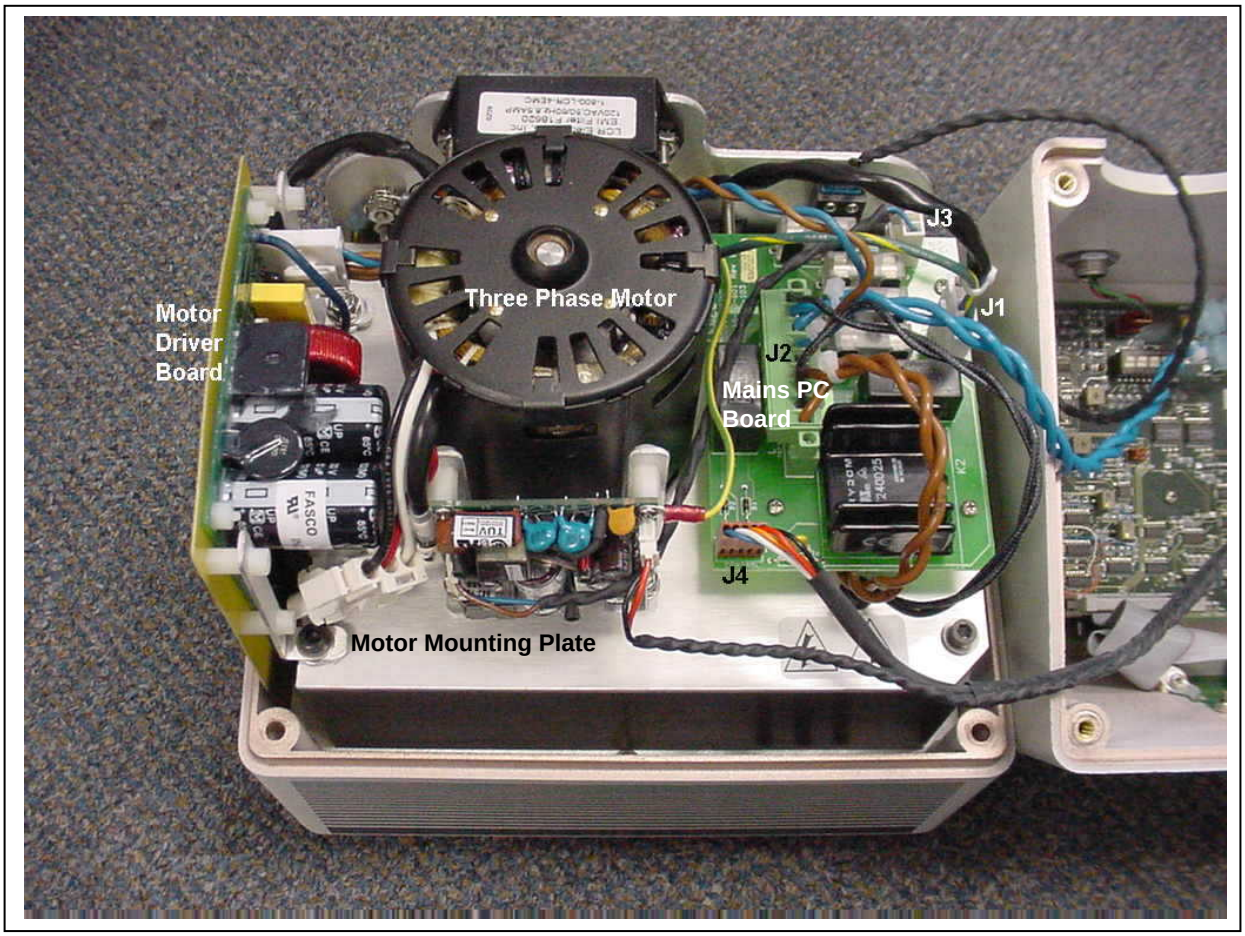


Figure A-5 Enclosure Base Wiring

B Troubleshooting

Appendix B contains symptoms and possible causes and solutions for troubleshooting problems with the device.

General Failures

Symptom	Possible Cause/Solution
The device will not activate when the ON button is pressed.	1. If No AC power is detected at J1 on the Mains Electronic Assembly, • Power cord is defective or cut. • Poor power cord insertion or connection. • Mains filter is damaged. 2. If AC power is detected at J1 on the Mains Electronic Assembly, • Fuse F1, F2, and/or F3 have/has blown. • Mains Electronic Assembly connections are bad or intermittent. • The 5V power supply is not functioning; output is at or below 4.5V. • Fuse F4 on Control Electronic Assembly has blown. • System Clock is not functioning- check TP20 = 2KHz. • Control Electronic Assembly has malfunctioned.
Device does not complete self-test.	See following section, *Self-Test Does Not Complete*.
Device bypasses self-test and goes directly to ambient or malfunctions completely.	1. DIP switch 1 on SW1 on the Control Electronic Assembly is in the TEST position. Verify that all switches are in NORM position. 2. Device was dropped on top and the Control Electronic Assembly is damaged.
Blower is on with the Power OFF	Control Electronic Assembly Q1 or Q9 failure.
Detect a burning smell during and after the self-test	Heater is always ON. • Mains Electronic Assembly solid-state relay K2 has failed. • Control Electronic Assembly heater servo loop has malfunctioned.

Airflow Failures

Symptom	Possible Cause/Solution
No airflow **Note:** *If heater was on with no airflow, the impeller may be damaged and may need replacement. Disconnect the power cord from the electrical outlet. Inspect entire impeller by shining a light through the air outlet.*	1. If the motor is running, • Hose is plugged. • Air intake is restricted. 2. If the motor is not running, • Hose electrical connector is disconnected. • Connector J7 or J8 on Control Electronic Assembly are disconnected. • Motor cable connections are not correct. • Motor fuse F5 on Mains Electronic Assembly has blown. • Impeller is restricted and unable to spin. • Motor Driver Electronic Assembly, if installed, has malfunctioned.
Weak airflow	1. Filter is dirty. • Replace with new filter. 2. Motor Driver Electronic Assembly has malfunctioned or the speed is not correctly adjusted. • Adjust speed. Refer to *Test 3: HI Temperature Test* in Chapter 3 for procedure to adjust speed.
Too strong airflow or noisy	1. Air filter is missing. 2. Air filter is not fully covering the plenum intake (only with two-piece air filters). 3. Motor Driver Electronic Assembly has malfunctioned or the speed is not correctly adjusted. Refer to *Test 3: HI Temperature Test* in Chapter 3 for procedure to adjust speed.

Heat Related Failures

Symptom	Possible Cause/Solution
Temperature display is more than 1°C below or above setting.	1. Hose being used is not the hose shipped with device. 2. Verify by performing the Functional Test and Calibration Procedure. (Refer to Chapter 3).
No heat when the blower is running and a Temperature setting (39°C, 40°C, 44°C) is selected.	1. If Disconnect LED is lit, • Control Electronic Assembly or cable connections have failed. See following section. • Mains Electronic Assembly Heater control solid-state relay (K2) has failed. • Heater or cable connections have failed.
Temperature proceeds to safety alarm at any setting (including ambient).	1. Control Electronic Assembly has failed. 2. Heat control solid-state relay has malfunctioned.
Temperature exceeds 4° above setting during safety alarm test (holding a temperature select button for 8-10 sec).	1. Perform the Functional Test and Calibration Procedure. (Refer to Chapter 3.) 2. Control Electronic Assembly has failed.
Device runs at ambient but the Disconnect LED lights when a temperature setting is selected.	Heater or heater circuit is open. • Check connections at Mains Electronic Assembly. • Check blue wires and quick connect terminals to the sensor transformer on the Control Electronic Assembly. • See Troubleshooting, below.

Self-Test Does Not Complete

Note: *Where the test stops may be an indication of the area of trouble.*

Symptom	Possible Cause/Solution
Disconnect LED is immediately on and stays on, no airflow is detected, and the temperature reading is approximately '00'.	Check the thermistor cable connections for the hose.
The temperature reading is between 00°C and 30°C.	1. Check that the hose air connector is fully inserted to the interlock switch inside air outlet on the rear of the device. 2. Disconnect the power cord from the electrical outlet and check physical function of the microswitch with a finger on the inside top of the air outlet. There should be a distinct "click" as it operates. 3. Try a second hose if the thermistor cable connection is suspect.
Note: *There is no delay before starting self-test unless the hose end temperature is above the Over Temp trip point for the newly selected temperature (e.g. Shutting off at 44° and right back ON, selecting 36°). Under this condition, the device may beep and the display may be irregular until the device drops below the Over Temp point for the newly selected temperature (e.g., 39°). This could take up to 10 seconds.*	
The Disconnect LED flashes three times and then stops.	There is an issue with the alarm circuit.
The Disconnect LED flashes twice then continues to flash or stays ON or OFF without a beep, or the alarm indicator turns on, and the self-test does not complete.	There may be heater current when there should not be. 1. Turn OFF the device immediately. 2. Disconnect hose air connector and check if air at the outlet is being heated. 3. If not, there is an issue with the heater current sense circuit. 4. Check that all leads of R107 are firmly attached to the Control Electronic Assembly and/or adjust the TP107 threshold per current specifications. Refer to *Preliminary Voltage Checks and Adjustments* in Chapter 3. 5. Retest with the top on the device.

Self-Test Completes

Symptom	Possible Cause/Solution
Device turns on but the Disconnect LED lights when a temperature other than Ambient is selected.	1. Turn the device OFF and disconnect the power cord from the electrical outlet. 2. Jump TP2 to TPG to disable the heater current detect circuit. 3. Set DIP switch 1 on SW1 to TEST to bypass self-test. (The device will not pass self-test with the heater current circuit disabled.) 4. Plug device in and press the ON button. Press 44°C. The Disconnect LED should not light. The "'CS" LED by D13 should light. 5. Check for one of the following two conditions: a. If the Disconnect LED is now OFF and the device operates normally, the problem is in the current sensing circuit. • Check that all leads of potentiometer R107 are properly soldered. • Check that voltage at TP107 is correct. Refer to *Preliminary Voltage Checks and Adjustments* in Chapter 3. • Check TP2. Turn device OFF and disconnect the power cord from the electrical outlet. Move the jumper to TP1 and TPG. Plug device in and press the ON button. Press 44°C. TP2 should be at a low voltage level when the HEAT CONT LED by J4 is lit and approximately 5V when off. (Comparator U42A has an open collector output.) b. If the Disconnect LED is now OFF and the temperature does not rise, the problem is in the heater circuit and its control. • Check that the HEAT CONT LED by J4 is ON. ▪ If it is ON, the problem is not on the Control Electronic Assembly. Check if there is AC voltage (100V/115V or 230V) to the heater at J2 (the long green connector) on the Mains Electronic Assembly. - If J2 pins 1&8. = 100/115/230V = bad heater. - If J2 pins 2&8. = 100/115/230V = bad Mains Electronic Assembly jumper foil. - If J2 pins 3&8. = 100/115/230V = bad connections to current transformer on Control Electronic Assembly. ▪ If it is not ON, the problem is on the Control Electronic Assembly. Check circuit from Q5 working back toward TP1. 6. Disconnect jumpers and set DIP switch 1 on SW1 to NORM.

Thermal Runaway – Device Causes T-Stat to Open

Symptom	Possible Cause/Solution
Motor Stopped	The T-Stat opens if the motor is stopped while a temperature is selected. This happens because there is no delivery of heated air to the hose-end sensors. **Note:** *When this happens, always check the impeller for heat damage.*
Motor Running	The T-Stat opens if the heater is constantly on, or if the airflow is greatly reduced. 1. If the temperature reading is normal, • Check for a crushed hose. • The device may have been used with a restricted air outlet. 2. If the temperature increases, (look on Control Electric Assembly) • If HEAT CONT LED is OFF, then the Mains Electronic Assembly solid-state relay K2 has shorted. • If HEAT CONT LED is ON, then the Control Electronic Assembly heater servo loop has malfunctioned.

Safety Leakage Test

Symptom	Possible Cause/Solution
High leakage – especially reverse polarity	1. Be sure there is no permanent connection between the motor mounting plate and the rear chassis (EARTH GND). 2. Check for an earth ground wire that was removed, and not reinstalled correctly.

C Specifications

Appendix C contains the system specifications:

Standard Compliance	
Product Safety	EN 60601-1, UL 2601-1
EMC	EN 60601-1-2, FCC 47 CFR Part 15, Class B
Enclosure Protection	IEC 60529 IP Code: IPX1
Convective Warmers	ASTM F2196-02
Physical	
Height	30 cm (11.75 inches)
Width	24 cm (9.5 inches)
Depth	19 cm 7.5 (inches)
Weight	6.8 kg (15 lbs)
Airflow	7.7 to 9.0 m/sec (1520 to1780 feet/min) 1.02 to 1.19 cmm (36.6 to 42.9 cfm)
Filtration System	0.2 micron filter
Environmental	
Operation Temperature	
Temperature	10°C to 40°C
Humidity	10 to 95% (non-condensing)
Transportation	
Temperature	-18°C to 60°C
Humidity	5 to 95% (non-condensing)
Storage	
Temperature	5°C to 40°C
Humidity	5 to 95% (non-condensing)
Thermal	
Temperature Set Points	36° ± 1°C 40° ± 1°C 44° ± 1°C
OverTemp Trip Points (Set Temp)	36°C = 39° ± 1°C 40°C = 43° ± 1°C 44°C = 47° ± 1°C Ambient = 47° ± 1°C
UnderTemp Trip Points (Set Temp)	36°C = 33° ± 1°C 40°C = 37° ± 1°C 44°C = 41° ± 1°C
Thermostat (Normally Closed)	Opens @ 70° ± 3°C Resets – when power to the device is turned off
Heater Resistance (Cold)	100V = 10.5Ω – 11.1Ω 115V = 15Ω - 17Ω 230V = 60Ω - 65Ω
Hose End Temperature	36° ± 1°C 40° ± 1°C 44° ± 1°C

Electrical		
Mains Power Input	100 VAC, 50-60 Hz, 8.7 Amps 115 VAC, 50-60 Hz, 8.05 Amps 230 VAC, 50-60 Hz, 4.0 Amps	
Protection Against Electrical Shock	Class 1 Equipment Type BF	
Mode of Operation	Continuous	
Type of Current	Alternating	
Ingress Protection Rating	IPX1	
Fuse Ratings, Control Electronic Assembly	F4 = 400mA	
Fuse Ratings, Mains Electronic Assembly	100/115 VAC F1 (line) 10A TL F2 (neutral) 10A TL F3 (PS) 0.5A – 1A TL F5 (Motor) 2.5A TL	230 VAC F1 (line) 5A TL F2 (neutral) 5A TL F3 (PS) 1A TL F5 (Motor) 2.5A TL
Normal Polarity	500uA MAX	
Reverse Polarity	500uA MAX	
Open Supply (Single Fault)	1000µA MAX	
Ground Bond Test	25 amps for 6 sec $\leq$100 mΩ	
Switching Power Supply Assembly	AC Input: 85-264 VAC, 47-63 Hz Output: 5V, 7W (Mfr Spec)	
Hipot Test	1500V for 1 second	

D Parts List

Appendix D contains the list of parts that can be ordered. Contact Smiths Technical Service Department or Smiths Medical ASD to order parts.

	P/N	Description
1	80-04-019	Air Filter Replacement Kit
2	60-14-005	Power Supply
3	60-24-016	Mains Filter (100V/115V/230V)
4	77-00-018	Receptacle Bead Assembly
5	60-40-048	Membrane Switch (Control Panel)
6	64-02-066	Air Outlet
7	64-02-064	Plenum
8	77-00-910	Microswitch Assembly
9	66-02-010	Motor - 3 Phase 100V/115V/230V
10	66-02-011	Motor Driver Electronic Assembly – 3 Phase 100V/115V/230V
11	66-03-015	Heater – 100V [must also order gasket (62-37-009)]
11	66-03-013	Heater – 115V [must also order gasket (62-37-009)]
11	66-03-014	Heater – 230V [must also order gasket (62-37-009)]
12	62-37-009	Gasket (Heater)
13	62-07-034	Cord Connector Lock Set (Wire Loop and anchors)
14	66-04-009	Impeller
15	70-02-102	Control Electronic Assembly
16	70-02-103	Mains Electronic Assembly
17	72-06-029	Pole Clamp
18	77-00-016	Servo Connector (Thermistor Input Connector Assembly)
19	77-00-901	Cable Assembly, Mains to Power Supply
20	77-00-904	Ribbon Cable Assembly
21	70-06-025	Mains Distribution Cable Assembly
22	77-00-911	Cable Assembly, Mains & Power Supply to Control Electronic Assembly
23	60-23-039	F1, F2 - 115V Mains Fuse 5x20 10A 250V Time Lag
24	60-23-045	F1, F2 - 230V Mains Fuse 5x20 5A 250V Time Lag
25	60-23-005	F3 - Fuse 5x20 1A 250V Time Lag
26	60-23-043	F5 - Fuse 5x20 2.5A TL 250V Time Lag
27	62-23-030	Hose Elbow (excluding NeoNatal)
28	SW5-HOSE7	Hose, 7’
	SW5-HOSEN	Hose, NeoNatal
	Contact Salesman	Power Cord – International (Application Specific)
	60-61-900	Power Cord – Domestic Only

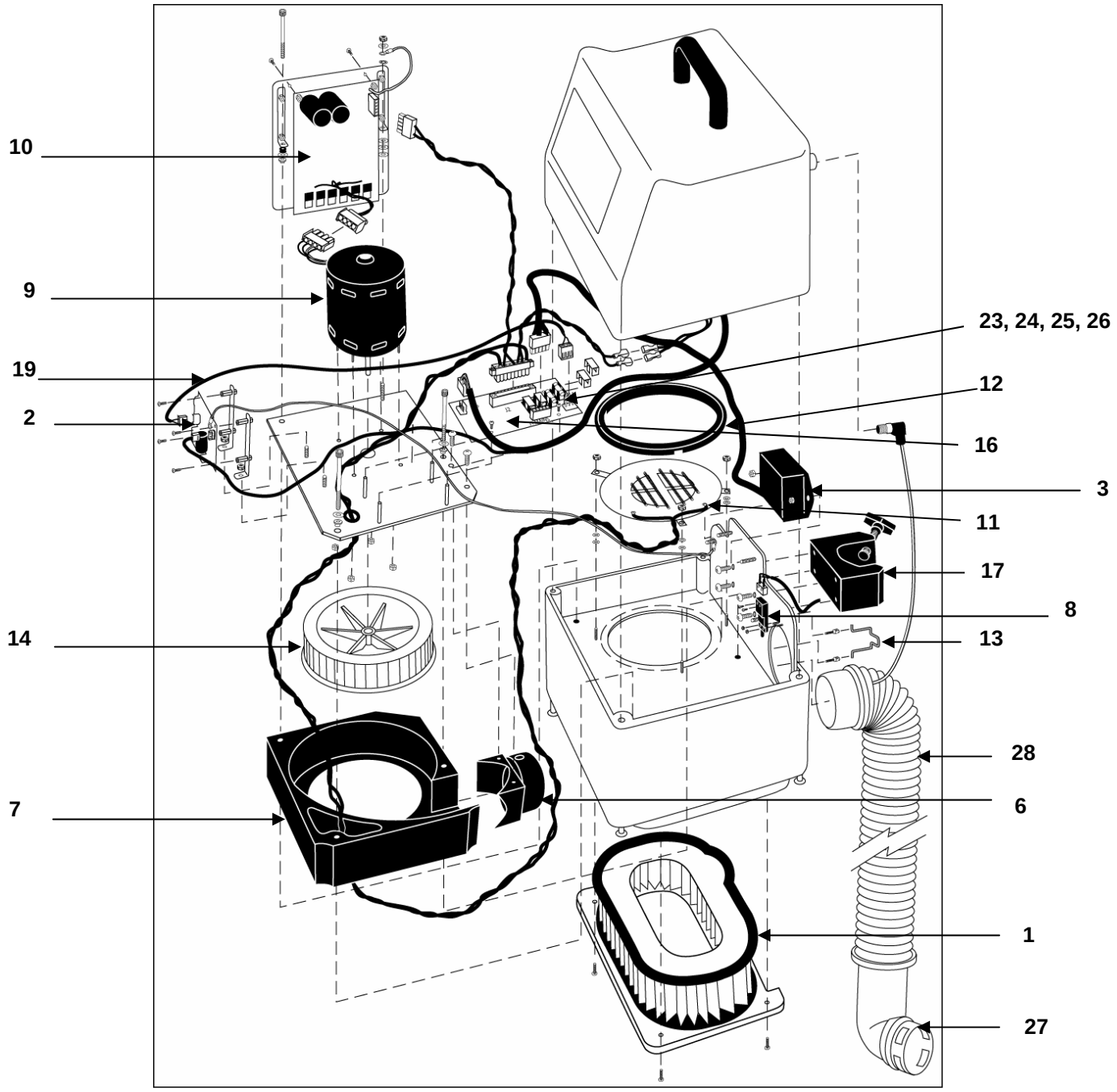


Figure D-1 Enclosure Base Parts Exploded-View

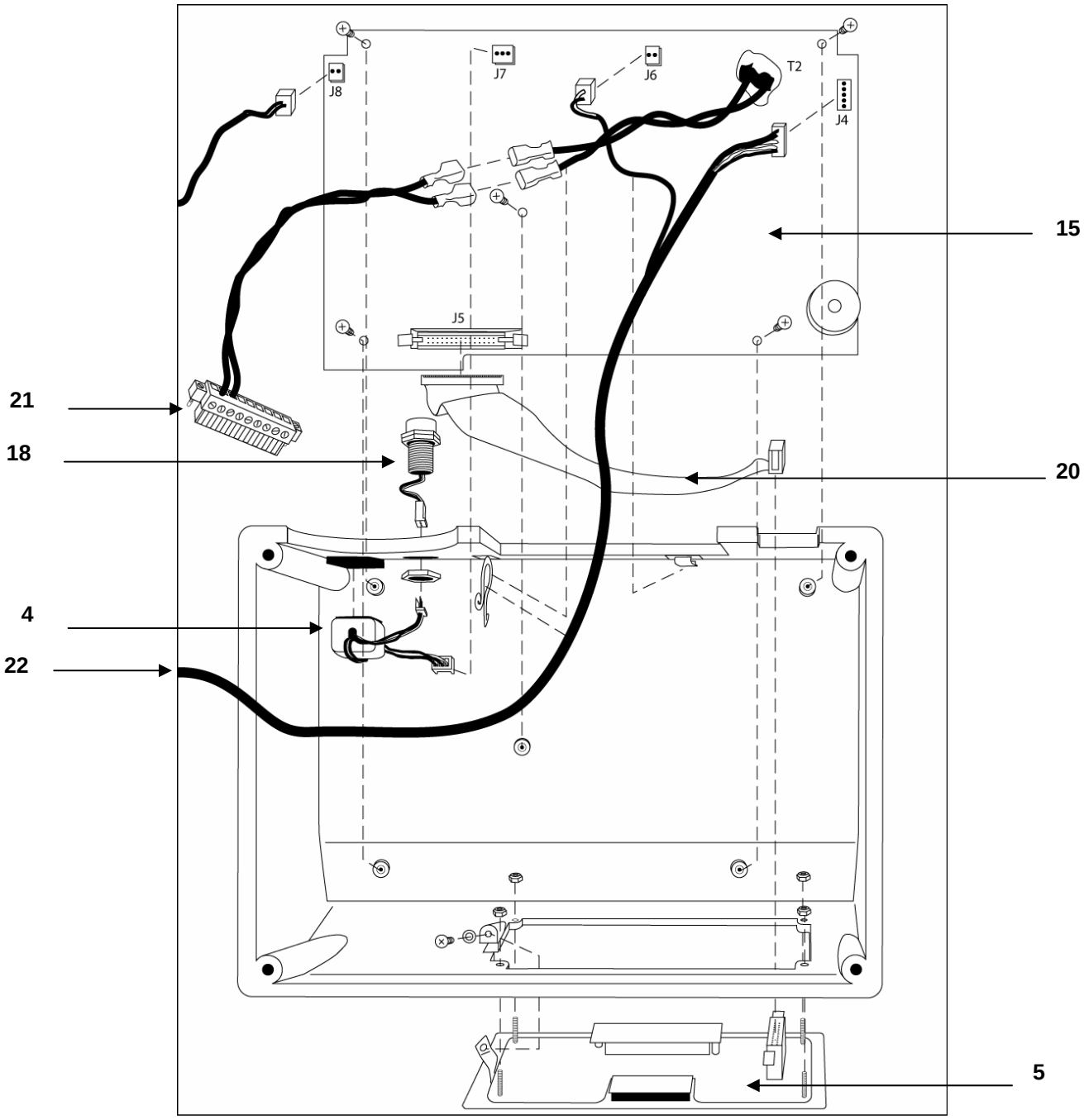


Figure D-2 Enclosure Top Parts Exploded-View

E Schematic Drawings

Appendix E contains the following drawings:

- Mode Select Control Schematic
- Temperature/Blower Control Schematic
- Mains Electronic Assembly Schematic
- Interconnect Schematic
- Meter/Power Supply Cable

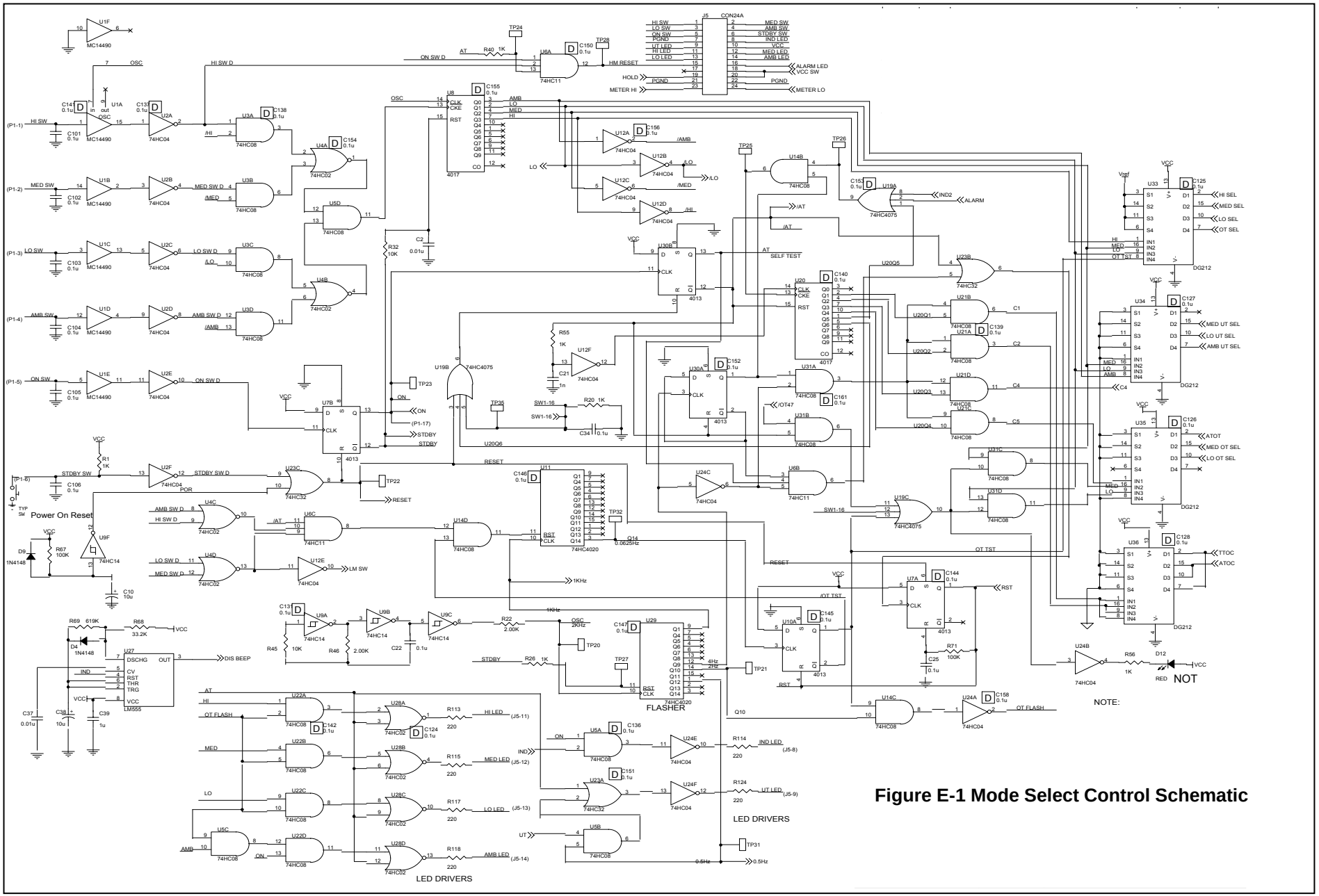


Figure E-1 Mode Select Control Schematic

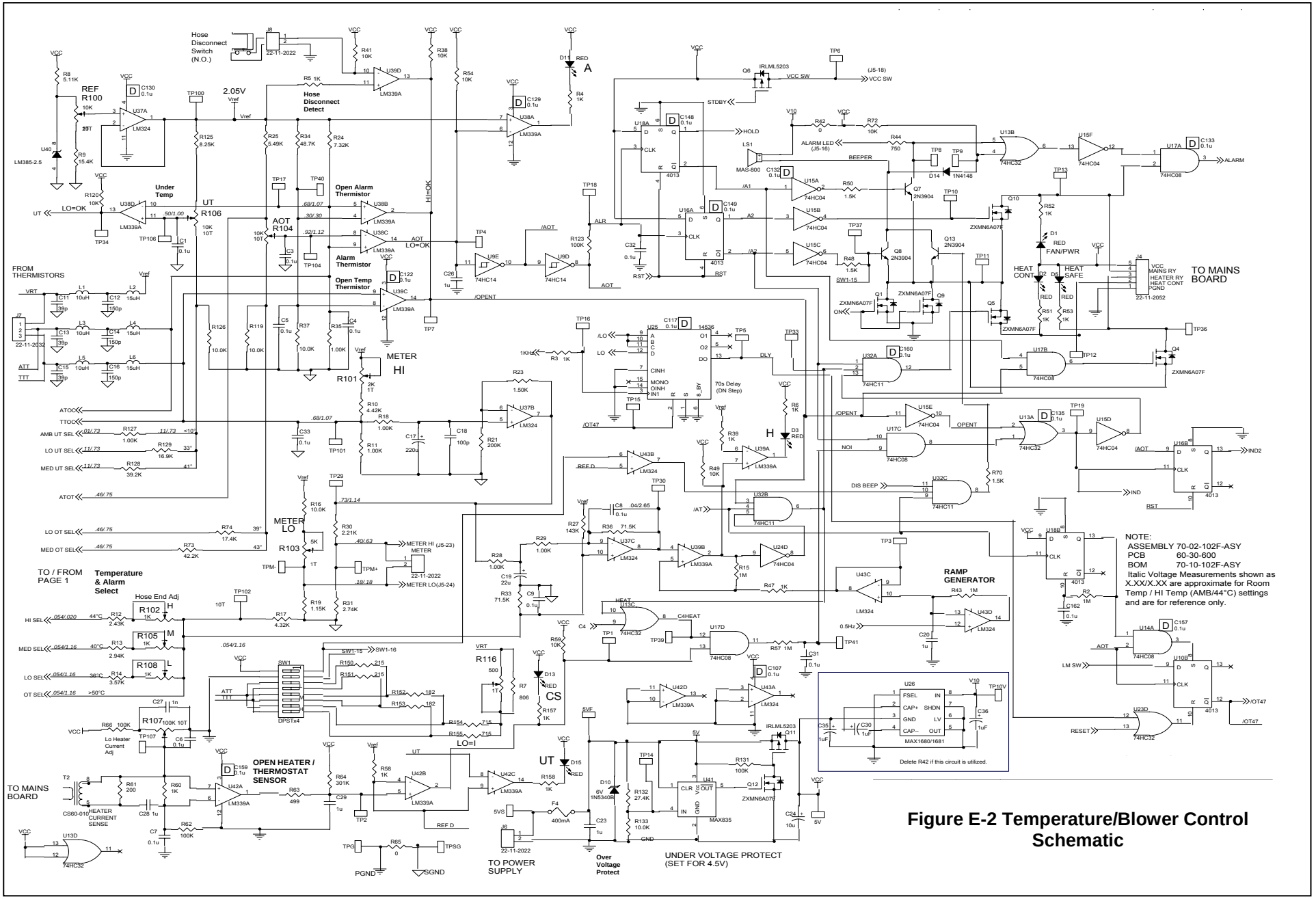


Figure E-2 Temperature/Blower Control Schematic

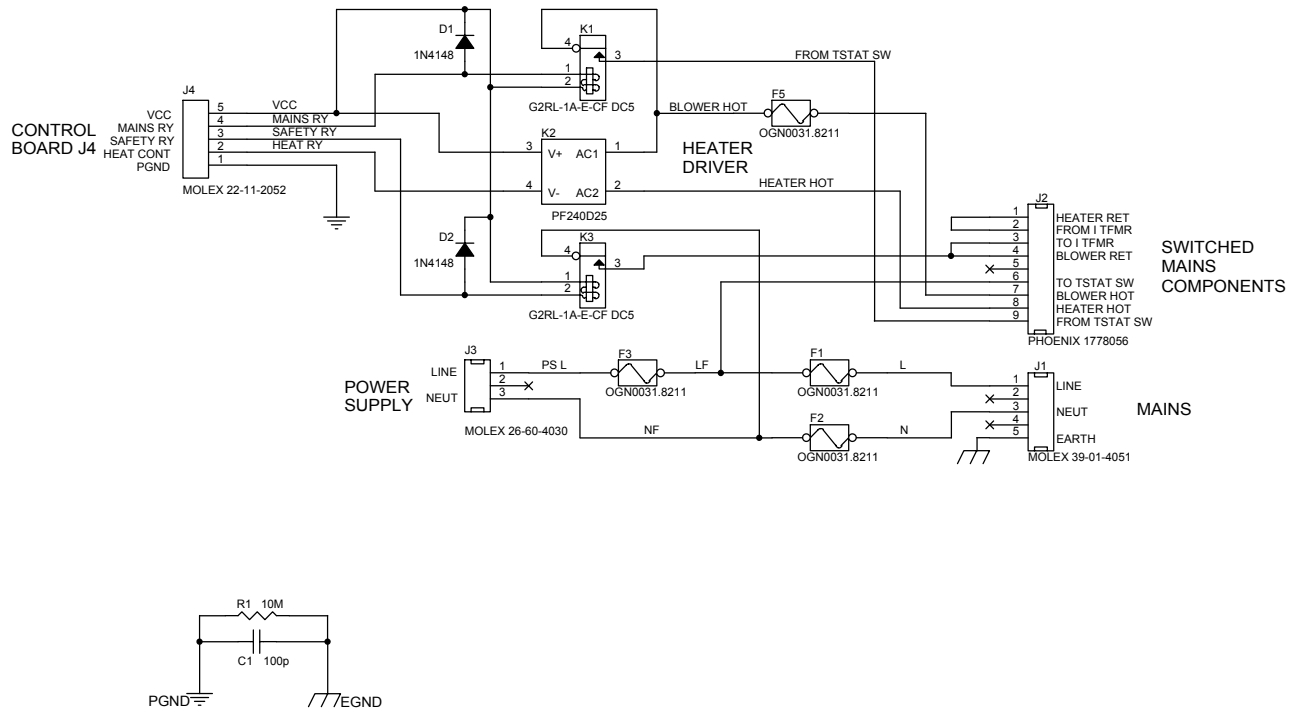


Figure E-3 Mains Electronic Assembly Schematic

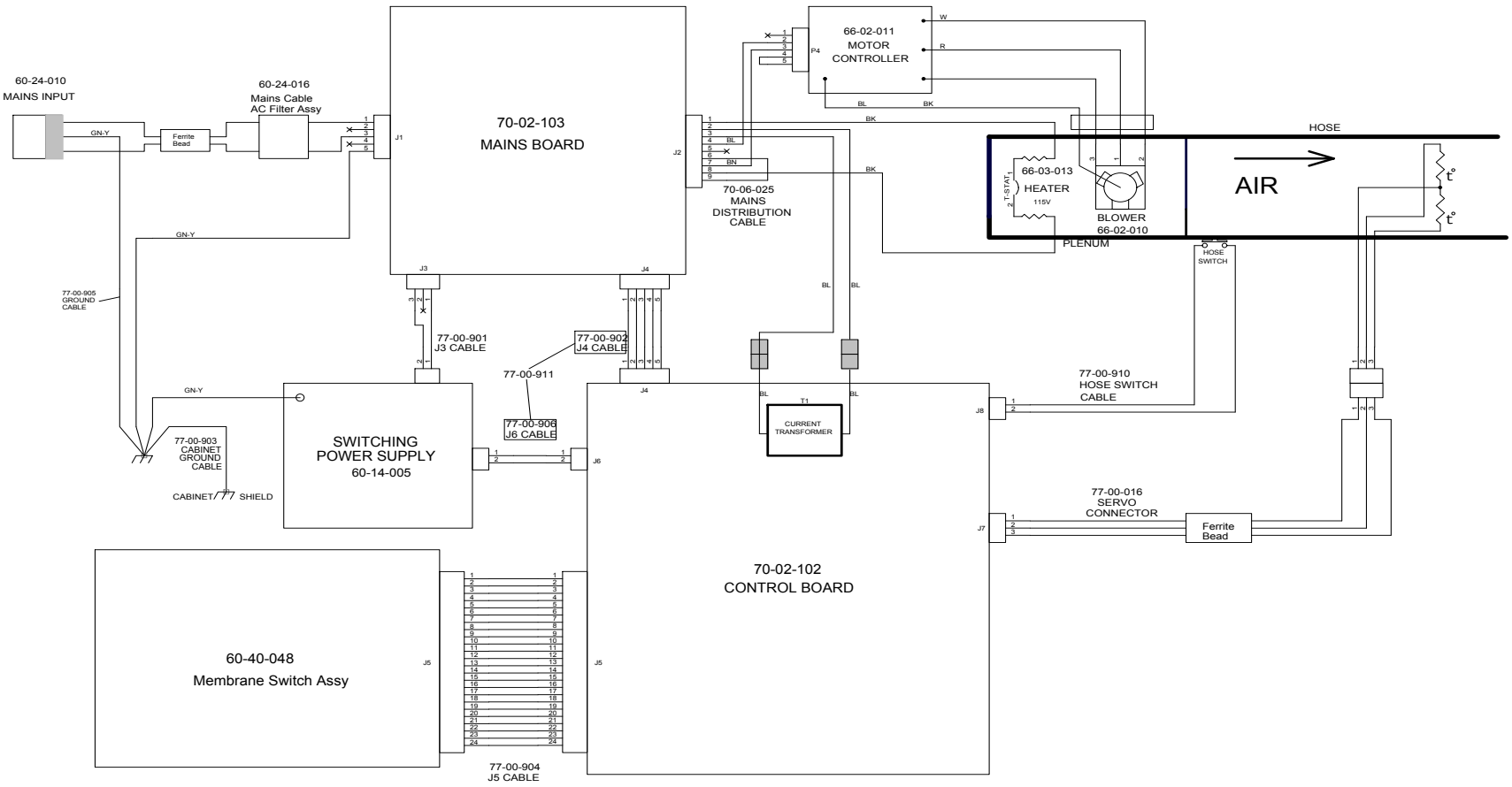


Figure E-4 Interconnect Schematic

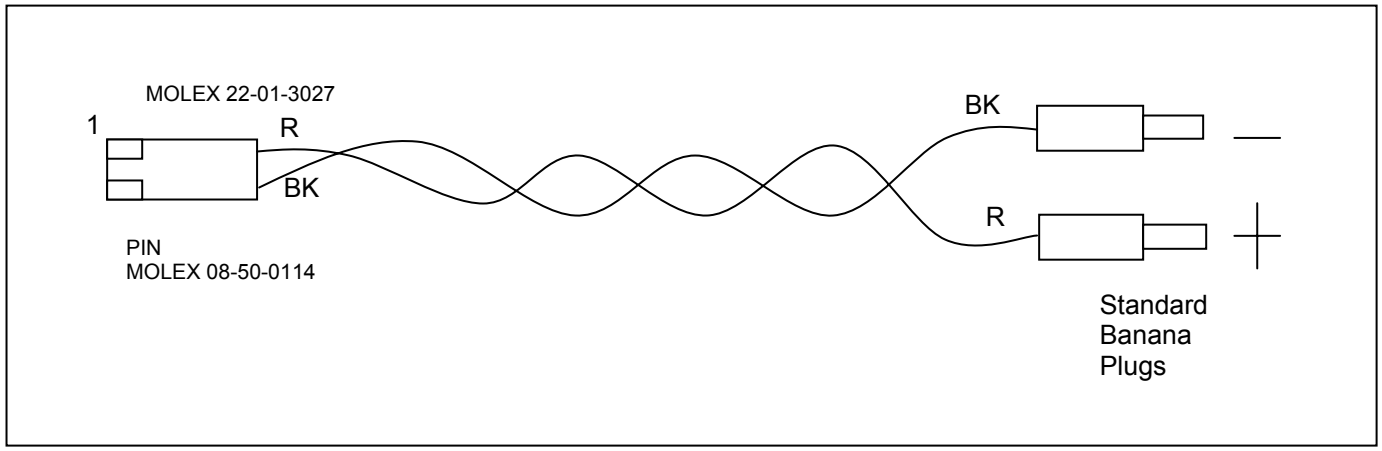


Figure E-5 Meter or Power Supply Cable

Maintenance Log

Date	Elapsed Time	Maintenance Task

Maintenance Log

Date	Elapsed Time	Maintenance Task